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Hon. S. A. Green,
of Boston,
29 May, 1882.

State of Connecticut.

THIRTEENTH ANNUAL REPORT

OF THE

SECRETARY

OF THE

Connecticut Board of Agriculture,

1879-80.

Printed by Order of the Legislature.

HARTFORD, CONN.:
PRESS OF THE CASE, LOCKWOOD & BRAINARD COMPANY.
1880.

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MAY 29 1882

Gift of
Hon. S. A. Green,
of Boston.

To the General Assembly of Connecticut:

In accordance with the provisions of the Act creating a State Board of Agriculture, I have the honor to present the Report for 1879–80.

T. S. GOLD, *Secretary.*

West Cornwall, January 7, 1880.

STATE BOARD OF AGRICULTURE.

1879-80.

His Excellency CHARLES B. ANDREWS, *ex officio*.

APPOINTED BY THE GOVERNOR AND SENATE.

		TERM EXPIRES.
E. H. HYDE,	Stafford,	1880.
ALBERT DAY,	Brooklyn,	1881.
H. L. STEWART,	Middle Haddam,	1880.
J. T. ROCKWELL,	West Winsted,	1881.

ELECTED BY THE AGRICULTURAL SOCIETIES.

Hartford County,	J. C. Capen,	Bloomfield,	1880.
New Haven County,	J. J. Webb,	Hamden,	1881.
New London County,	James A. Bill,	Lyme,	1881.
Fairfield County,	Jona. E. Wheeler,	Saugatuck,	1880.
Windham County,	Charles H. May,	East Woodstock,	1880.
Litchfield County,	C. T. Hickox,	Watertown,	1880.
Middlesex County,	J. M. Hubbard,	Middletown,	1881.
Tolland County,	William Holman,	Tolland,	1881.

ELECTED BY THE BOARD.

T. S. Gold, West Cornwall, *Secretary.*

OFFICIAL LIST.

Governor Charles B. Andrews, *President.*

E. H. Hyde,	Stafford,	*Vice-President.*
T. S. Gold,	West Cornwall,	*Secretary.*
Nathan Hart,	West Cornwall,	*Treasurer.*
Prof. S. I. Smith,	New Haven,	*Entomologist.*
Prof. W. H. Brewer,	New Haven,	*Botanist.*
Prof. S. W. Johnson,	New Haven,	*Chemist.*
P. M. Augur,	Middlefield,	*Pomologist.*

E. H. Hyde, T. S. Gold, H. L. Stewart,
Commissioners on Diseases of Domestic Animals.

J. T. Rockwell, J. M. Hubbard, H. L. Stewart
Auditors.

REPORT.

THE twelfth annual meeting of the Connecticut Board of Agriculture was held at the United States Hotel in Hartford, Jan. 15, 1879, at 10 A. M., Hon. E. H. Hyde, Vice-President, in the chair.

Present, Messrs. Hyde, Rockwell, May, Day, Hickox, Wheeler, Capen, Hubbard, and Gold.

The report of the Secretary was read and accepted.

On motion of Mr. Rockwell, a committee of three on Credentials were appointed by the chair. The committee consisted of Messrs. Rockwell, Day, and Wheeler.

During the absence of the committee, the Secretary read a letter from Mr. Stewart, excusing his absence, from illness.

The committee reported as members elect, J. J. Webb of New Haven County, James A. Bill of New London County, J. M. Hubbard of Middlesex County. With regard to the member from Tolland County, the committee reported that in view of the action taken two years ago, they would recommend the recognition of Judge Holman from Tolland County East, providing that that society have made their returns according to law.

In proceeding to the choice of officers, the following resolution was adopted:

Resolved, That the Governor of the State be the President of the Board.

The official list was then filled as follows:

E. H. HYDE, Stafford, *Vice-President.*
T. S. GOLD, West Cornwall, *Secretary.*
N. HART, West Cornwall, *Treasurer.*
Prof. S. W. JOHNSON, New Haven, *Chemist.*
Prof. W. H. BREWER, New Haven, *Botanist.*

Prof. S. I. SMITH, New Haven, *Entomologist.*

P. M. AUGUR, Middlefield, *Pomologist.*

E. H. HYDE, T. S. GOLD, H. L. STEWART, *Commissioners on Diseases of Domestic Animals.*

J. T. ROCKWELL, J. M. HUBBARD, H. L. STEWART, *Auditors.*

Upon the passage of the resolution appointing the Governor President of the Board, a committee consisting of Messrs. Day and Bill were appointed to wait on Gov. Andrews, inform him of his election, and invite him to be present.

Resolved, That the committee on the Diseases of Domestic Animals be authorized to employ veterinary assistance at their discretion.

The report of the Treasurer was presented and referred to the auditors.

A committee consisting of Messrs. Rockwell, Gold, Webb, and Hubbard were appointed to determine time, place, and subject for the winter meeting.

The Vice-President and Secretary were authorized to secure lecturers for the year when expedient.

The Board adjourned to 2 P. M.

The Board met according to adjournment at 2 P. M., Gov. Charles B. Andrews in the chair.

The report of the Commissioners on Diseases of Domestic Animals was read and accepted.

On motion of Mr. Day,

Resolved, That the Secretary be instructed to procure a steel engraving of Hon. E. H. Hyde, to be inserted in the next report.*

Gov. Andrews, in reporting the resolution to Mr. Hyde, who was called in, very happily referred to his gratification in performing this his first official act in connection with the Board of Agriculture, presenting a testimonial so richly earned by long devotion to the agricultural interests of the State.

On motion of Mr. Hubbard,

Resolved, That a sum not exceeding two hundred and fifty dollars be appropriated to Prof. W. O. Atwater, for expenses incurred in preparing for publication the results of the experimental work he has had in charge.

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* The portrait appeared in the report for 1878, the expense having been provided for by gratuitous contributions.

The auditing committee having examined the Treasurer's report, found it correct, and the report was accepted.

The subject of Farm Experiments with Fertilizers was presented, resolutions and amendments offered and discussed, when the subject was laid upon the table.

Resolved, That the Secretary be directed to ask of the General Assembly the printing of 2,000 extra copies of the Annual Report.

Resolved, That the Secretary be directed to confer with the Comptroller upon the expediency of binding copies of the Report of the Experiment Station with the Annual Report.

Resolved, That two members of the Board be appointed, with the Secretary, to visit farms in Fairfield County.

Messrs. May and Bill were appointed, with power of substitution.

The Vice-President and Secretary were authorized to arrange for members visiting fairs.

Voted, That one hundred dollars be paid to P. M. Augur for his services.

Voted, That Hon. E. H. Hyde, Hon. J. E. Wheeler, and the Secretary be a committee to confer with the Comptroller or the Legislature in regard to rooms for the Board in the State House.

Adjourned to 7 P. M.

The Board met at 7 P. M., Hon. E. H. Hyde in the chair.

The chairman announced the sudden death of William Mattoon of Springfield, Mass., and the following resolutions were passed:

Resolved, That it is with extreme sorrow that we learn of the death of William Mattoon of Springfield, Mass. His eminent success as a breeder of Devon cattle, his skill as a progressive farmer, his character as a gentleman, his energy and integrity as a business man has been too well and too widely known to need our endorsement, but we feel that we are called upon to offer this our testimony to his worth.

Resolved, That we present to his family our hearty sympathy in their bereavement.

Resolved, That a copy of these resolutions be presented to the family of the deceased, and to the papers for publication.

The delegates to fairs were then arranged as follows:

HARTFORD COUNTY, Messrs. Wheeler and Augur.
State, at Hartford, Oct. 1, 7–9.
Suffield, Oct. 8, 9.
Pequabuck, Oct. 1,—Bristol.

NEW HAVEN COUNTY, Messrs. Bill and May.
At New Haven, Oct. 1–3.
Milford and Orange, at Milford, Sept. 10, 11.
Guilford, Oct. 8.
Meriden, Sept. 17, 18.
Waterbury, Sept. 16, 17.
Woodbridge and Bethany, Sept. 24, 25.

NEW LONDON COUNTY, Mr. Holman.
At Norwich, Sept. 23–25.

FAIRFIELD COUNTY, Messrs. Capen and Day.
At Norwalk, Sept. 23–26.
Danbury, Oct. 8–11.
Union, Monroe, etc., Sept. 17–19.
Ridgefield, Sept. 30 to Oct. 3.

WINDHAM COUNTY, Messrs. Stewart and Hickox.
At Brooklyn, Sept. 2–5.
Woodstock, Sept. 16–18.

LITCHFIELD COUNTY, Messrs. Rockwell and Augur.
Woodbury Union, Sept. 16, 17.
Housatonic, at New Milford, Oct. 1–3.
Watertown, Sept. 23–25.
Union, Falls Village, Sept. 9–11.
Torrington, at Wolcottville, Oct. 14, 15.

MIDDLESEX COUNTY, Mr. Webb.
No Fair.

TOLLAND COUNTY, Mr. Rockwell.
At Rockville, Sept. 24, 25.
Tolland County East, Stafford Springs, Oct. 1, 2.

The Board then adjourned *sine die*.

A special meeting of the Board was held at Willimantic, December 16th, at 7 P.M., Gov. Charles B. Andrews in the chair.

Present, Messrs. Andrews, Day, Stewart, Rockwell, Webb, Bill, May, Hickox, Hubbard, Holman, and Gold.

The Secretary detailed the arrangements for the session, and some of the work of the Commissioners on Diseases of Domestic Animals.

The remainder of the evening was occupied with a general discussion of various plans of work for the Board.

Adjourned to Wednesday evening, at 9 o'clock.

The Board met according to adjournment, Vice-President Hon. E. H. Hyde in the chair.

The Secretary read the report of the annual meeting, which was accepted.

The Secretary reported that he had obtained a portrait of Hon. E. H. Hyde for insertion in the last Annual Report, according to the instructions of the Board, and the subscription list to cover the expense. He also reported the action of the committee on rooms for the accommodation of the Board in the new State House. Also, the action of the General Assembly increasing the number of reports to be printed from three thousand to five thousand.

Adjourned to Thursday, 9 P. M.

The Board met Thursday, Dec. 18th, at 9 P. M.

The Secretary presented the subject of testing dairy apparatus under the supervision of the Board, and various plans were discussed; and on motion the following resolution was passed:

Resolved, That a committee, consisting of the Secretary and Treasurer, be instructed to communicate with the manufacturers of the different kinds of dairy apparatus offered in the market, and ascertain on what terms they will offer their articles for a test of their merits by the Board during the coming year, and that the committee report at the annual meeting.

The chairman of the committee on Diseases of Domestic Animals made a verbal report of the action of the committee in regard to the bone disease in cattle, and the following resolution was passed:

Resolved, That the Commissioners on Diseases of Domestic Animals be authorized to pay Dr. Noah Cressy fifty dollars for a satisfactory report on the bone disease in cattle.

The Board then adjourned *sine die*.

T. S. GOLD, *Secretary*.

FARMERS' CONVENTION AT WILLIMANTIC.

The usual winter meeting of the Board was held at Franklin Hall in Willimantic, December 17, 18, and 19, 1879, and the several sessions were attended by good audiences, who listened to the addresses and discussions with manifest pleasure and interest.

His Excellency Gov. ANDREWS, President *ex officio* of the Board, called the Convention to order at 10.30 A. M., on Wednesday, December 17th, and said:

I take pleasure in introducing to the audience present our distinguished fellow-citizen and very eminent agriculturist, who has been renowned in the State for his personal and civic virtues, Lieut. Gov. HYDE, who will make the opening address.

GENTLEMEN: I greet and congratulate you with profound pleasure. The year intervening since our last annual meeting has been freighted with the abundant gifts and blessings of a most benignant Providence. The eclipse that so long veiled the smiling face of prosperity has passed away. The skies above us are bright, and we can see smooth sailing ahead.

Business through all its channels and ramifications has awakened from its torpor, like mother earth in response to Southern breezes and the more ardent glances of the spring-tide sun. Our own beloved State, famous the world over for the skill of its artisans, and the invention and construction of their useful and innumerable wares, was perhaps never more busy and prosperous than at the present time. The insidious and justly dreaded cattle disease which has, in its various forms, kept up a sort of guerrilla war upon the cattle in places near our western border has been baffled at every point of attack, and the Commissioners, who have been alert and active in the field, are happy to say that they believe that it has at the present time no foot-hold upon our soil.

I take this opportunity, in behalf of the Cattle Commission to thank the railroads generally throughout the State, who have so cheerfully assisted us in our work by giving free passes. We are under special obligation to the New London Northern and the New York, New Haven & Hartford railroads, over which most of our pleuro-pneumonia and other work has been done, for granting me and our veterinarian every facility asked for, and giving us a free pass for our work, and enabling us to advise with the New York Commission, and for executing our orders in refusing to transport stock from the infected districts. Without this help we should not have been able to have accomplished so much, there being no special act of the Legislature providing for this expense. I regret to say we did not succeed in obtaining the same facilities over the New England road, in our pleuro-pneumonia work at Watertown, and other places on the line.

Gentlemen, I join heartily with you in the deep regret occasioned by the declination of our worthy chief magistrate to make the opening address. It was earnestly hoped that we might have a word of cheer and good counsel from one who, while bearing so well the dignity of his high office, can bend gracefully to that simple felicity of speech in which he conveys distinctly and even vividly to plain minds the ideas gathered from wide reading and a large and abounding experience. Gentlemen, with every recurring annual meeting of our Board we find that the great interests which we have the honor to represent are steadily advancing, and out-fruiting with ever widening and more abundant harvests. Old and worn forces, by a skillful adjustment of pinions and bearings, have given a vastly increased momentum and directness of aim.

While the saving in the wasteful cost of grinding and wearing friction makes ample compensation for that reduction in prices which ever follows large facilities and a more general competition, men who are growing old in the study of the elements of earth and air and tide, and who in mysterious laboratories, in the midst of crucibles and retorts and dissolving glasses, have watched the motions and measured the manifold and ever-changing evolutions of matter on its way from principles to results, and have brought to light the secret substances of tree and root and blade, and the compounding of the strange ingredients that nourish the flesh and fiber of vegetation, and in which the deadly sulphates even are made to minister unto life, are now enlisted in the beneficent work of emancipating agriculture from the thraldom of the tread-mill, and elevating it to the foremost rank among human industries. Ah, gentlemen, it is not this alone that they are doing, but something grander. They not only elevate agriculture as an industry, but they also exalt it as a profound and universal science, old as man, and make it glorious with their transcendant illuminations. Before the marvelous microscosm of the laboratory, wherein we with our untaught eyes catch glimpses of the hidden mystery and very core of things, we stand at first bewildered and awe-smitten, but with hearts filled with gratitude to Him through whose grace this splendid revelation has been made possible.

Farmers in past times too often tilled the soil in a dull, blind way. They knew but little concerning its nature or its capacity and wants. The best they over-fed, the poorest they starved, and so mismanaged generally that in the course of time the whole was reduced to poverty, and considered as skinned, or worn out. You will find all over New England hundreds of farms that are considered skinned, or worn out.

The old folks are waiting to die on them; the young folks have run away. On hillside and knoll you see the brown and feeble acres; they have a pinched and hungry look. A few of the most fertile patches were pampered and grossly over-fed, and they yielded for a time good grass and corn in abundance. But they had stomachs that were not to be abused for ever. They did not run to blotches and boils like over-fed bipeds, but to weeds and vile fungi, followed by dyspepsia and general debility. The poorer and tougher portions of land, including morbid wood-lots, were ranged by cattle and sheep. A slope here and there gave scanty crops of potatoes, or of rye or buckwheat. Special rotation to any great extent was out of the question, even if it was thought of, for the amount of soil considered worth cultivating was too limited to admit of a healthy variety. Grass, potatoes, and corn divided the best of the realm, and each held its own territory inviolate. Pumpkins, however, crept into the corn; beans grew round about as if by accident, while daisies invaded the mowing-lots like an army with banners.

We have now been taught that the soil, like the animal and vegetable creation, has its physical members and functions. It has appetite, and eats and drinks; it has a stomach, and digests its food; it has lungs, and breathes the air; it has a heart, and branching veins and nerves; it suffers with hunger and thirst, and with heat and cold; it sleeps and wakens; it has a language of its own; it expresses joy and sorrow almost as intelligibly as the brute; it has its tender passions, and loves the sunshine, and the gentle rain, and the hand that kindly pats it, and it has also passions that are less amiable, for it resents neglect and insult, and makes itself sick with sulks and sour temper under ill treatment. This homely personification may be called childish, but all the same it carries with it a lesson to the mind and heart of the thoughtful and devout farmer. Many of our good fathers looked upon the barn-yard brute, though kind enough to him in their way, as a thing without attributes. He was useful, he was of more value than a turnip—but not to be compared with a dog or cat. The horse received the earliest recognition in our better period, but to-day our horned cattle more than any other class of farm stock show the results of an enlightened appreciation, and are giving, in return for the care of a watchful eye and the touch of a gentle hand, a docility and simple affection that well agree with the grace and beauty of the fine lines of their high and careful breeding.

The dairy-cow of the day, if not the queen of hearts, is a power behind the throne that rules all happy hearts in feasting times. Her signet with the brand of the golden star is put in the place of honor, and graces the center of the board in the midst of gathered flowers, and vines, and the fruits of the yellow sheaf. But have we reached in the best of all, in the one consummate flower, if such an one there be, of our highest and most splendid culture, the ideal cow of our dreams? Have all possibilities been compassed, and have we produced by mixing the choicest of the blood, or by inbreeding culled specimens from remote branches of any one famous strain, attended by untold expense, and almost infinite study and care and patience, a cow that shall be the mother of a long and priceless line—the mother of a race that shall be equally vigorous and hardy in all our various latitudes and all of our diversified soils, and that shall swing as large and as rich an udder and as large and as fine a loin among the ferns and short grasses of the hills as in the deep vales and meadows, billowy with a verdure that is rooted in the unwasting delta of the ages? Have we in brief a cow that shall meet with equal success each of the three great demands of the dairy, which are, that her milk shall be copious, rich in delicate oil for butter, and abound in caseine for cheese, and yet, though a dairy cow, shall meet still another demand, and combine in one identity all the desirable qualities of the race by furnishing beef that shall tempt the eye and charm the palate of the epicure? If we have not produced such a peerless creature, and if still pressing forward we find in the last reasonable analysis—beyond which we may indeed go, but at our peril—that one star still differeth from another star in its glory, shall we therefore despair? Rather shall we not say, the Lord's will be done, and with the Christian grace of content-ment give the nimbus to ideal cows of sections and for special qualities, and glorify them according to their fitness for localities and their ability to successfully meet the leading demands of localities, whether they be of the English, or Dutch, or Channel Islands breed in their purity, or crossed with each other, or graded with our natives.

Gentlemen, it was my good fortune to be present at the recent dairy exhibition at Greenfield, Mass., and at the grea international fair last week in New York. The first show did not of course equal in magnitude the second, which was simply immense. But I felt proud of what I saw at Greenfield, especially the butter, the little pats of which looked so fresh and bright that I fancied one might see them shining in the dark. At New York I was amazed. I have no words to describe the great spectacle. It impressed me with a profound sense of the tremendous interests involved in the dairy productions of the country.

I refer with pleasure to the agricultural societies throughout this State, as having made better exhibitions than at any time previous. The county societies more especially to be noticed are the New London, New Haven, Fairfield, Windham, and Tolland, while among the town societies, nearly all of which have been prosperous, Danbury as usual leads the list. A more special notice will be given them by the visiting committee.

The PRESIDENT. The audience are desired to give their attention to a paper on "The Right of the State to disseminate Agricultural Knowledge," by R. S. HINMAN, from the office of the Secretary of State.

THE RIGHT OF THE STATE TO APPROPRIATE MONEY FOR THE DISSEMINATION OF AGRICULTURAL KNOWLEDGE.

BY R. S. HINMAN OF OXFORD.

In my use of the word *right* in this paper I do not put it in the sense of power. The State may if it chooses apply its funds to *any* purpose. That it may rightfully do so is quite another thing, and it is in this sense that I have frequently heard the question asked, " By what right do the farmers of the State receive an appropriation yearly, for the purpose of holding conventions and publishing documents containing information for their benefit? Why should not the State appropriate a similar sum to enable the retail grocers to hold conventions and discuss the best methods of carrying on their business? " The question is a pertinent one, and without any buncombe about a sturdy yeomanry being the bulwark of the commonwealth, and holding a vast amount of virtue in reserve for supplying the wastes of our towns and cities, or reference to any other side issues, I propose to consider the matter as it concerns the State in a pecuniary way.

Let us consider, first, whether the question as usually asked does not betray some slight ignorance on the part of the querist as to the object of such a meeting as this. The inference would seem to be that we come here at the expense of the State for the purpose of advancing our own interests, or at most, the individual interests of a class following a particular avocation. If this inference were correct, the question might well be asked, and we should find ourselves extremely puzzled to give a plausible answer. There can be no more unjust tax than that which burdens the many for the benefit of a few, or of a particular class, unless such benefits reciprocate to the advantage of all. The facts, however, are exactly opposite to the inference given. The men who attend these conventions do so often at great expense and loss to themselves, while the subjects discussed and lessons learned are of public interest, and not particularly beneficial to them as individuals. In this they may very properly be aided by the State.

It is not necessary for me to bring forward any argument in support of the assertion that no State or nation can long exist upon a thoroughly exhausted soil. The promised land might have been as populous with the descendants of Abraham to-day as China, had the system of agriculture adopted by the children of Israel been as rational as that of the inhabtants of the flowery kingdom. In some parts of England the soil has been for centuries entailed, belonging to the same families. These lands have been worked for as many generations by families of tenants, son succeeding father in the care of a few acres. You will readily perceive that any depreciation in the value or producing capacity of the land would result not only in loss to the land-owner, but in the long run to the tenants also. Let us view the State as in our case the land-owner, the succeeding farmers as tenants, and the taxes laid on the land as the rent roll. We have now a complete analogy, and as the great English land-holder must inform his tenants how they may so till their farms as to obtain a livelihood without exhausting the natural resources of the soil, so the State must, if it consults its own interests, teach the farmers who have its lands in charge this same lesson, and that it is not wise to kill the goose that lays the golden egg in the hope of getting quickly rich.

With the example of China maintaining the fertility of her soil for ages, of England, France, and Germany, with the vast progress in agriculture they have made in the last score of years before us, it is useless to shut our eyes to the fact that it is possible to so manage the farms of our State as not only to maintain their original fertility, but make them return a waxing instead of waning income. You may tell me that it is for the interest of the farmer who has a farm easily tilled to grow all the crops he can, corn while that will pay, and then rye and buckwheat until the last atom of producing power is exhausted, and with his ill-gotten gains go West. I say you may tell me this, but I shall not believe it, and it is for the interest of the State of Connecticut, that every farmer within her borders learns how untrue this doctrine is, and how to avoid unintentionally practicing it. There are towns in this State in which the land is more productive than it was twenty years ago, where the son can get a living on the farm his father left him; and I challenge any State in this nation or any nation in the world to produce a community of farmers richer in all that makes this world worth living in than the inhabitants of these towns. Contrast such towns with others where the "get all you can" policy has been adopted, and the land so reduced in productiveness as not to maintain sufficient population to support churches and schools, except it may be in a feeble and discouraging way, and tell me which is better for the State, and better for the farmers as a class and as individuals.

It is for the interest of every farmer that his neighbor's farm be kept in the highest state of productiveness. It is for the interest of every manufacturer and every merchant that the farms surrounding them be kept at their best. Understand me now, I am speaking of farms, not farmers. Let me illustrate by supposing, and I need not rely upon fancy for instances, that in a certain school district there were in 1850 twelve farms, worth on an average $5,000. Here would be an aggregate of $60,000 as a basis of taxation for roads, schools, and other public purposes. The land-holders, with the necessary help for carrying on the business of farming, would make a population sufficiently large to give this little neighborhood the advantages of society, schools, etc., at a moderate cost. Now let us suppose that since 1850, six of those land-owners have reduced their farms past profitable productiveness, grown rich or poor, I don't care which, and drifted away, leaving their worn-out farms to be added to the other six, or, unoccupied, to grow up to brush. Is anything plainer than that on the remaining six farmers will be thrown the burdens carried by the twelve before? No amount of mercantile talent would have made Robinson Crusoe a very successful merchant, but if Friday had been a fair customer, and the cannibal islanders visited him respectably often, his chances would have ranked those of a merchant surrounded by farms in the last stage of decline, and which produce barely sufficient to sustain the life of their occupants.

. The great fundamental law of self-preservation demands that the State educate the tillers of its soil. It not only has a right to appropriate its money for this purpose, but a duty to perform, which it would be unwise in the extreme to shun. Like the public schools, the agricultural prosperity of our State should be considered, not in its relation to individuals, but to the commonwealth. You may tell me, and tell me truly, that my neighbor's child will be able to earn a better livelihood for being educated, but there is no justice in taxing me to that end. You may tell me that he will probably be a better man and stand a better chance of eternal happiness if he is educated, but the question of my pecuniary interest in the welfare of my neighbor's soul was settled in the negative in this country years ago; you cannot tax me for that. When you tell me that our existence as a republican nation depends upon the intelligence of our citizens, and that with a steady influx of foreign ignorance it would be suicidal to turn our State into a hot-bed for its propagation, I must successfully controvert your assertion or pay my school tax without a murmur. I am then equally interested, and may be rightfully taxed whether or not I have children to send to school. The productiveness of the soil of our State is a matter in which all, whether merchants, manufacturers, or professional men, equally with farmers, are interested.

We are occasionally told that many of the farmers of our State do not ask instruction. Granted. Grant, if you choose, that a majority of them do not, and I am not sure that we should concede too much; it only makes the necessity on the part of the State the greater. If the farmers themselves were once thoroughly awake to the truth of the matter, they would, in caring for their own interests, protect the interests of the State. It may be that in this convention there are those who think I'm crying wolf! wolf! when there are no wolves; that the State has no cause for alarm. I am aware that it is somewhat customary to open a paper of this kind with an array of figures, and follow with deductions from them. I have noticed, however, that figures have a somniferous effect upon most audiences, and, wishing to have you hear a part, at least, of my paper, I have reserved my figures till this opportunity presents itself for introducing them.

In 1857 the value of the land, in sixty-three of the most exclusively agricultural towns in this State, as given in their grand lists, was in round numbers nineteen millions of dollars. In 1877, twenty years later, the same lands were assessed at but fifteen and one-half millions of dollars. In other towns, manufacturing villages, and cities the value of land has increased; but it is safe to allow for an equal amount of depreciation in the value of land for agricultural purposes in the remaining 104 towns. This would give us a total loss in twenty years of seven millions of dollars, or about $350,000 annually. You may think that, to the patriotic citizen of Connecticut, there should be no overpowering narcotic influence about these figures. Perhaps not. The man who has the best interests of his family, his town, his State, and his race at heart will be wide awake to all this, or wake up at the merest whisper. The other man—the man who kills his goose, or who ruins a farm in his native State, and goes West to continue his devastations on virgin soil—may be a very different sort of man. If aware of what he is doing, he must necessarily be ungrateful and selfish. To reform him we must convince him that it is better for him to so manage his farm that, as he advances in years, it will pay him a larger income, and be more and more valuable; and that when his diminutive soul leaves this fair earth, he can rest assured that he will leave more of this world's goods behind him than he could hope to by any other method. Assure him of this, and that his spirit will go where the streets are paved with gold, and his very selfishness may make him an earnest worker for the public good.

I left the consideration of the depreciation of the value of our farms without reverting, as perhaps I ought in that connection, to the fact that some of our farms are more productive than they were twenty years ago. I want to be fair to my brother farmers, and look on all sides, and here is my way of looking at this. But for these exceptional cases we might have been in doubt whether our soil and climate were adapted to the maintenance or increase of the fertility of our soil. Thanks to these exceptions for the removal of all doubt. Had the period during which this depreciation took place been one of general business depression and declining values, we might find cause for it, and some excuses in favor of the owners of these lands; but 1857 was before the rebellion. Since then our manufacturing towns and their population have vastly increased. We have the best of markets at our doors, and our only trouble is that we cannot raise enough to supply them. Within the present century the hillsides of our State have profitably grown grain for export to the West Indies.

I know of farms from which men who are now living hauled corn and oats twenty-five miles to New Haven with oxen, for export, that to-day hardly grow grain enough to keep the teams that drew those crops off without being stimulated by special fertilizers. In those days it didn't take $9.50 worth of phosphate to grow $10 worth of corn. Our forefathers didn't spend their time in conventions of this kind. They had agricultural discussions, but generally over their cider of an evening, or over their toddy at the village tavern, and the subject for discussion was likely to be: How shall we best subdue our fields? Judging by the results I think they argued that question to some purpose, for their old corn fields are frequently seen so subdued that in the half century that has elapsed since they were planted they haven't grown vegetation enough to cover the corn hills. It is that system of subjugation that must be eradicated from us, and thoroughly eradicated, before we can manage our farms in the interests of the State, ourselves, and our descendants. For this purpose the State may profitably spend yearly much more than it ever has done, if it spend judiciously. A $350,000 leak requires more than a $5,000 plug.

It is not my province at this time to discuss the efficiency of the various agencies for teaching farmers. The Board of Agriculture, Experiment Station, State, county, and town fairs are all useful, and the usefulness of all might and hould be increased. It may be well, however, to call the attention of agricultural societies and other bodies controlling the State appropriations for agricultural purposes to this point when they are considering how to use the money at their disposal. The farmers of Connecticut are not paupers; they are not applicants for State charity, and as individuals they are not entitled to State aid if they did ask it. Whatever is to benefit the commonwealth is a legitimate object for the expenditure of public money, but private purses, whether of the few or many, are not proper receptacles for such money. It is quite proper to teach a farmer at the expense of the State how to increase the value of his land, and thus increase the permanent wealth of the State. It is quite a different matter to teach him to increase his cash in hand at the expense of the real value of his estate.

I shall not, however, read this Board nor the agricultural societies of the State a lecture on the legitimate use of the money at their disposal. The subject of appropriations was what I set out to present, and having briefly done so, and hinted at the fact that there is a chance for much wise discrimination in the use of the money appropriated, I leave it with you.

Mr. **Nathaniel B. Perkins** of Willimantic. I wish the farmers present would occupy the half hour that remains before the recess in questioning Mr. Hinman. Almost all the interests in the State, manufacturing or other interests, directly or indirectly, receive some public appropriations, either through the tariff or in some other form, and I wish the farmers would make themselves free here to ask him any questions on this subject that they choose. I would like to ask him one. Can he give us the exact appropriations made by our State for the promotion of agriculture, and if in his judgment more should be appropriated, in what way should it be devoted?

Mr. **Hinman.** I cannot tell the exact amount. Probably Mr. Gold can come nearer to that than I could; but somewhere from five to six thousand dollars annually. Not very far from $6,000, I think, is the usual appropriation. I do not know that I should want to make any change in the disposition of it. The most of it is at present spent either by the Board of Agriculture or by the State and smaller agricultural societies. I think the State society had some $2,500 this year; last year I think they had $3,000. Some of the county societies have $200 and some $100. Undoubtedly under the present method of spending that money some of it is expended to no very great advantage to the State. It would naturally be so, but I should hardly want to criticise it even if I knew of any place where there was a leak of a dollar. The only way is for the farmers to get their best men in the county societies, and to get the best men they have in the county societies on the Board of Agriculture, and in that way avoid the misspending of money as far as possible. At the same time there is no doubt in my mind that all the money that is now appropriated, and more, could be used beneficially to the State.

Mr. **Harry Sedgwick** of Cornwall expressed his dissent from the views presented by Mr. Hinman, instancing the success of private efforts in advancing the cause of agriculture in comparison with associated effort, but in closing said, "I believe it is the duty of the State to disseminate agricultural knowledge, but at the same time I believe it is the duty of the State to do it as cheaply and as economically as it can, and through the most available means."

Gov. **Andrews.** I came here as a hearer. The paper which has been read is entitled "The Right of the State to disseminate Agricultural Knowledge." It seems to me that that is a question which is not really at issue now, because the State of Connecticut has practically decided that question by establishing a Board of Agriculture and making an annual appropriation for it. The national Government has done substantially the same thing through its Bureau of Agriculture, so that the naked question of the *right* of the State to do it has been already decided. The real, practical question to be discussed, and the one which is of interest to the farming community to-day is, How shall the money so appropriated be used that it shall be of the most advantage to the farmers and everybody else throughout the country? And that leads out into a very broad field and involves the questions; first, who are the farmers that may be benefited? and second, for what branches and in what way shall the money be expended? Every body who is familiar with the history of Connecticut knows that within the last seventy-five years the population of the State has nearly doubled; but all of that increase of population has been confined to a very limited number of towns. We have 167 towns in this State, and this increase of population has been confined probably to 50 towns—I presume to even less than 30. At least 100 towns in the State have not increased any, and a large number have actually decreased. In the county of Litchfield, where we have 26 towns, 16 of those towns since 1840 have actually decreased their population, and have decreased their taxable lists. In the county of Windham the proportion is not quite as great as that, but almost as great. Of the 16 towns in the county of Windham I believe there are but five that since 1850 have increased their population; some have actually decreased, and the others stand at just about the same number.

There is another thing. Not only have these towns decreased in population, not only have they decreased in their taxable value, but they have decreased in another respect which is not so obvious: they have decreased in their capacity to support population. That is something that mere figures do not illustrate. Take a town in Litchfield county that is now in my mind, and it actually is not capable of supporting as many people or as many animals by at least 30 per cent. as it was twenty-five or thirty years ago. Now there is a field to which the Board of Agriculture may profitably direct their attention. How can you restore to the town of Colebrook, or some other town, the capacity that it had thirty or forty years ago? That is a question of very great practical importance, not only to the Board of Agriculture of this State, but to every manufacturer, and, indeed, to every citizen of the State, whether a private citizen or holding any office. It is a very grave question that addresses itself directly to the Legislature, and to every person who is interested in the government or in the administration of this State. I speak of that town, not because it is worse than any other town, but simply as an illustration. You can all, the moment your attention is called to it, think of some town within your own acquaintance where precisely the same state of things exists. It is not only true that the population is decreasing in such a town, and its value is decreasing, but its producing capacity is decreasing, and all of those elements upon which the strength, the wealth, and the prosperity of the State must be predicated are becoming less. There is a field for you.

I advance a little further, and I ask the Board of Agriculture who are the farmers, the agriculturists that you desire to benefit? I take it that if a man comes from New York city, or from Boston, or any where else—a man of wealth, having a very large income from other sources than his farm—and buys a farm in Connecticut, and puts up elegant buildings, and goes into some sort of farming, which, without any disrespect, I may denominate "fancy farming"—in other words, a man who goes on a farm and risks some capital upon it in the same way that some other man may spend his money upon fast horses or yachts, I do not believe that he is farming in any proper sense of the word. I think of a town within which I have caused investigations to be made—a town where there is not a hammer nor a spindle of manufactures—an absolutely agricultural town, where at least three-quarters of the men who own land have mortgages on their farms. These are the men who are supporting their families, seeking to rear families to take the places in the next generation which they now hold, supporting schools and churches, supporting the poor, building the roads, and doing it all from the produce of the land which they till. They have no bank stock, no manufacturing stock, nor anything of that description. Now, it seems to me that there is a class to which the Board of Agriculture might with very great propriety direct its inquiries, and if anybody can be helped, help these. Not by giving them money. The farmers of this State are not beggars. But teach them how they may help themselves; tell them how they may make their farming more profitable; tell them how they may raise better crops and more profitable crops—raise them with less expense and with less labor.

I will illustrate this idea in another way. Here is this village of Willimantic, which draws its supplies from all these hill-towns around it. The eggs, the butter, the milk, the cheese, the pork, the veal, almost everything you eat here, comes from some of these surrounding towns. The producing capacity of the soil is tasked year after year to feed the people who work in these factories, and, little by little, the productive capacity of the soil all around here is being reduced, and the fertilizing qualities that are produced from that soil go into this river. I want the Board of Agriculture of this State, if possible, to tell these farmers how they may take the fertilizing qualities of their farms which have been brought to Willimantic village, and carry them back to their land. There is a province within which the Board of Agriculture may very profitably work, as it seems to me.

I ought to say, by way of apology, that I am not a farmer. The only thoughts that I have upon this subject are such as have come to me in the office which I now hold, as the well-wisher of this State. And I close right here—because I could not begin to go over this whole subject in the few moments I ought to occupy—I close right here by repeating, that it is a matter of very grave importance to the people of this State whether its hill towns shall be depopulated and devastated, almost, by this slow process of carrying all the fertilizing qualities of the soil into the villages and towns where manufactures are carried on, or whether by some process, through the Board of Agriculture or some other instrumentality, these people may be so taught that these hills shall again be fresh and green, and every man who lives upon them not only find comfort and health, but also find prosperity and wealth.

Mr. W. P. Gage. One thought occurs to me. The Governor says the Board of Agriculture ought to contrive some way whereby the farmers can take the fertilizers from Willimantic, and return them back to the place from which they were originally taken. Supposing we export our grain to Europe, how shall we get the fertilizers from Europe here? I know our farms in Connecticut have depreciated for the last twenty years, and I know there is a great chuckle over the exports of grain to Europe this year and last year. It is simply exporting the phosphates out of the soil to Europe, and I want the Board of Agriculture to tell us how we are going to get the fertilizers back. Why should the valley of the Mississippi export its grain to Europe? Why not bring the manufactures here, where we can profit by them?

I simply make this remark here because it occurred to me when our friend spoke of what the Board of Agriculture was doing for this State. It occurred to me that here was a larger field than Willimantic furnishes for the efforts of this Board. Our surplus products are sent over the water, and millions of dollars in gold come back to pay for that grain, beef, pork, etc., sent over the water. How are we to get those fertilizers back? That is the question.

Mr. WEBB of Hamden. I have listened with a great deal of attention to the paper as it was read, and also to the remarks upon it. There is, it seems to me, a large field for this Board of Agriculture, for every agricultural organization in the State, and for the farmers of the State, to occupy, and the more we meet to discuss these subjects the more we shall promote our interests, and, as was suggested in Mr. Hinman's paper, the more the farms of the State are improved, the more their products are increased, the more wealthy is the State as a State, and the more happy and successful are the individuals comprising it.

Now, we will all admit that in many districts the agriculture of this State is in a condition of decay. Our farms are running down; the fences are falling; the buildings in many parts of the State are kept in comparative order; we will see a very good building here and there, painted occasionally, where the farms are growing up to brush and broom sedge, which is about as bad a grass as I can think of. Is there nothing to be done to remedy this? Is there nothing that can be done by the Board of Agriculture, no suggestion which we can make to change this condition of things?

Now, what is the reason of this decay within the last nineteen years? We have been living too fast during those years.

The young men have wanted to live faster than they could afford to, and so the labor has been taken from the farm, where the profits were slow, and where they could not see them except once a year, perhaps, and then, if they were at all ambitious, they would bury the money as soon as they could in some improvement, so that they could not see it. The young men said, "We must work in the factory, where we can get our money every Saturday night, spend it on Sunday, and get over it on Monday." There has been a great deal of that; a great deal of extravagance which was produced by the period of inflation through which we have passed, and the agricultural products have diminished. How shall this thing be remedied? It cannot be done except by a change in public sentiment which will make farming more attractive. How shall that be done? We have got to go to work and improve it little by little, according to our means, and then we must go and talk it over with our neighbors, and try to stimulate them, and create a rivalry to excel in improvement, and when public sentiment is changed, when this thing becomes realized in some way, we will start a new order of things.

There is another thing which I would like to say a word about. Have we laborers enough on the farm, and can we avail ourselves of that agricultural labor to improve our farms and bring them to that condition which our ambition should lead us to do? There are many farms in Connecticut which are falling away and diminishing in value every year. Many farms in Connecticut can be bought to-day for less than the buildings upon them are actually worth. These farms are for sale; the farmers are anxious to sell, and want the money for them. There are many old people who have farms who are unable to cultivate them, and they think they could live on the money a great deal better than they can live on the farm. Let us look at the condition of England and Scotland to-day. The laboring population are suffering severely. In the last five or six years they have lost the accumulations of years by bad crops, and they want to get away. There is a large emigration flowing to this country from there; where is it going? To northern Texas. Four or five hundred immigrants have gone through New York on their way to northern Texas within the last two months—probably more than that. I say that this State offers greater facilities to these emigrants than any other. Might not our State legitimately and profitably make an appropriation and spend some money to bring these facts to the knowledge of these people?

In regard to this matter of transporting our beef, our mutton, our pork, and our grain to England, and bringing back the money to pay for them, I think that makes us richer instead of poorer; but there are a great many refuse articles which we ought to use here. For instance, I will take the article of linseed oil-cake. Two-thirds of the oil-cake made in this country is exported to England. England has agents throughout our whole country picking up bones, putting them upon vessels, and taking them to England. This oil meal is a refuse material of which we are not availing ourselves, and with which we can feed our stock and our horses to our benefit. I know that some farmers say, "I do not believe in phosphates and oil-cake; they are not good; and if they were I couldn't afford to use them; and if I could I wouldn't use them, any how." Now, that is the last and only argument, and that knocks everything down.

Now, we can avail ourselves of a great many of these fertilizing materials which are transported to England, and which we ought to save. We can spread these bones upon our fields and produce more grass, the grass will feed more cattle, and we can send what we do not want to England or some other country where they do want them. And what does England do with our oil cake? After going to the expense of buying it, and the additional expense of transporting it across the ocean, what does she do with it? She feeds her beef with it. We can feed it here in the same way. Here is a new thing. Cotton-seed cake is now coming into the market in large quantities as an article of food for stock, a use to which it has never before been appropriated; and there are many different articles which have formerly been articles of waste that are now being manufactured and sent to England and to Scotland, of which we can avail ourselves to fertilize the hills upon which our cattle and sheep range. Let us use the waste; let us save all we can, and let us have the energy to use it to the best possible advantage.

Mr. WHITAKER of Massachusetts. I do not belong to the State of Connecticut, and I do not know that I have any right to say anything as to what the State should do in taxing its inhabitants. That is a question which belongs to the people of the State of Connecticut and the government. But there is one thing I will say on the questions referred to by Mr. Webb—What are we to do to make farming more attractive to the young men of the State? Well, I think that there has something occurred while I have been in this room that suggests one way, and perhaps the most effective way, of making farming more attractive to the young men of the State, and that is by adding, if there is any way of adding, to the respect and honor in which the calling is held by the community. I refer now to the fact that the Chief Magistrate of your State is here, and has thought it worth his while to address this meeting on this subject. Mr. President, if our leading men, instead of mounting the ladder to get up as high as they possibly can eleven months of the year, out of the reach of the people, would endeavor to keep down on the lower rungs, where they are apt to place themselves when they are seeking for an election, I dare say it would be of some benefit to the country at large.

This question of restoring the fertility and bringing back the prosperity of those towns which seem to have been depopulated is a large one. There are many causes for the present condition of things. The gentleman on my left spoke with regard to sending the fertility of the soil to Europe. He told a fact. I was brought up on the other side of the water, and know something about it. England cannot support her population without assistance from somewhere. A country is always increasing in fertility where the population is larger than the product of the soil. Wherever you find a country the products of which are larger than the population to consume them, you must expect to find, to a certain extent, depletion of the soil. There is no possibility of getting away from it. But, Mr. President, there is a debt which this country owes to agriculture, and we ought to pay it as soon as possible. In 1873, when the panic first struck this country, and when every person stood aghast, wondering what the result would be, England wanted our grain, and that fall gold came pouring into this country from England to pay for our crops. That gold helped at that time to avert the overwhelming disaster which was just upon us. The West, which got that gold, did not suffer as we suffered at the East. But it could not stay the whole force of the wave of disaster; it still flowed on, and the process of recovery was a slow one. And what was the condition of things at the beginning of this year? Why, farmers, merchants, and mechanics everywhere were suffering, and the great outcry was, "What is to come upon us?" Butter was selling in St. Albans the beginning of this year at 8½ cents a pound; cheese in Utica at 4½ cents a pound. Could any farmer produce butter or cheese at these prices and live? But these commodities went to Europe, and gold came back, and that gold that came back set in motion the machinery of the manufacturer and the tools of the mechanic all through the country, and the produce of the farmer went up as these industries started. It was the sacrifice that the farmer made on the altar of his country that put the wheel in motion, and the country is indebted to the farmer to-day for the prosperity we now enjoy and which is in prospect for us. I tell you it was a sacrifice. No farmer got fifty cents for a day's labor for the produce that went to England. And look at the condition of things. We are not sending these products to a prosperous country at the present time, but the country that is taking them is suffering terribly from short crops, the result of an unfavorable season, and we are reaping the benefit.

Let us look at this matter fairly. Let us put the farmer where he ought to be. No class of men, to my knowledge, ever made the sacrifices that they have made, particularly in the North and in the West, within the last two or three years. During the war things went "kiting" up, and while your sons were sent to the South to bleed and die, your coffers were filled with gold. But it was "robbing Peter to pay Paul," and within the last few years we have suffered, and that severely, as a consequence of the state of things that then existed. The financial disaster that fell upon us was the consequence of what had gone before. But the opening of a market for your products which you did not know what to do with, although the price was a low one, caused the gold to flow in, and that gold, as I said before, has started up the wheels, and now we can look with some degree of confidence for prosperity.

But there is one other point of difficulty with regard to this, and it is a serious one. That is, the matter of competition. Can Connecticut, with her hillsides worn out almost, with her depleted soil, can she at the present time compete with the fertile lands of the West? That is the question, and it is a serious one. Mr. Gardner, a representative from Minnesota to the International Dairy Fair, said the other night, "We can make butter or cheese in the West, we can send it to Boston or New York, we can ship it to Liverpool, and if the market there does not please us we can bring it back and sell it in New York, and compete with you and beat you of the East." Now, if that is the condition of things, there is another question which looms up before us which is of more seriousness than anything we have considered yet. That question is this: Are we at the present time producing all the agricultural products of different kinds that we might produce? We are sending out of the country somewhere in the neighborhood of ninety millions of dollars annually, I believe, for sugar. Can we not produce that sugar and save the ninety millions at home, or a large portion of it? I was struck the other day by seeing the statement that we were paying three millions annually for rice. Cannot that rice be raised at home? You will be astonished when I tell you that the other day, as I was walking through the streets of Boston, I met three wagon-loads of wool that was raised in England. We are sending corn to grow wool in England, and sending to England to buy that wool! Why, in the name of common sense, cannot Connecticut farmers grow as good wool as is ever grown in England or Ireland? I know they can grow better if they will. Now, there is a leading article of consumption, and certainly it is a matter of great importance, not only to the farmers, but to legislators and those who are endeavoring to steer the old ship of state, that they should look at these things and see if something cannot be done. Cannot the State do something to encourage the growth of the sugar-beet, that we may have sugar at home? Can we not do something, in some way or other, to encourage the production of various things which we now go to foreign countries to buy? Why, some of us go to Europe for our clothes. I recollect a gentleman in New York, with whom I was well acquainted, and who had spent thousands of dollars to secure the passage of a protective tariff, who once said to me, "Whitaker, it ought to be a penal offense for any man to wear any article of clothing that is not made in the United States of America." I put my hand on his shoulder, and said I, "Mr. Lawrence, where did your coat come from? The cloth was made in Germany. The same is true of your pants and your vest. The shirt and stockings you have on came from England; the patent leather of your boots is imported, and your hat came from Paris. You have not an article on your back that was not imported." I was at one of the meetings of the Wool Manufacturers' Association, and I will venture to say there were not ten men in that assembly that were not clothed in foreign goods. One thing we can do to help our manufacturers, and when we help them we help them to consume the products of the soil; and that is, patronize home industries.

Mr. SEDGWICK. I felt, when I rose to criticise the paper of my friend Mr. Hinman, that my remarks might possibly be misconstrued. The point for which I contend is this: not that we have not an efficient Board of Agriculture in this State; not that the money which the State has appropriated for that Board of Agriculture has not been well expended; not that the results of the meetings of this Board of Agriculture from year to year have not been felt throughout the State; and, sir, the glory of this Board of Agriculture will be that it has saved to this State thousands of dollars through its Experiment Station, which was instituted by its efforts. I do not criticise those things at all. But, sir, there is in the minds of the people a growing sentiment that they must knock at the doors of the Legislature for help whenever there is anything to done. I say this is wrong.

It is to stem this growing feeling among many farmers that all we have to do is to knock at the door of our Legislature for help that I rise here, and ask that my sentiments may be made known. I believe if we allow that feeling to increase it will react upon the farmers, and their condition will be ten times worse than before.

Mr. Perkins. I would like to call the attention of this convention and of the State Board to the uses that are made of the appropriations to some agricultural societies. I think that no gentleman who is acquainted with the doings of our experiment station at New Haven will find any fault with the use of the appropriations that are made for that station. I believe that our experiment station at New Haven has saved the farmers of Connecticut, of New England, and of all the States, a very large amount by driving from the markets a good many bogus fertilizers that are almost useless. I do not believe that any gentlemen here would say that the appropriation for that station should be reduced. But I do question the propriety of making an appropriation of several thousand dollars every year for fairs. At our agricultural fairs, as often conducted, we see the "wheel of fortune," where our young men and boys can learn to gamble, if they will. You may say that the same thing is to be seen at our church fairs; that does not make it any better; the effect is the same. Can we afford to appropriate money from our State treasury for the aid of so-called agricultural societies, at whose exhibitions our young men are learning to gamble? Then the same may be said of our agricultural horse trots, where we have a hundred dollars appropriated in premiums for wheat, corn, fruit, etc., there is a thousand dollars given as premiums to fast horses. Our little Farmer's Club, weak as it is, having only one hundred members, has held an agricultural fair three years in succession. We have never paid over ten dollars for any single premium, and I have seen a greater show of the products of the soil, of cattle, and everything of that kind which can be useful to the farmer, than we have at our county fair. We have not found it necessary, and, as a member of that Club, I for one should be ashamed, to ask the State to aid us. If we have not ambition and spirit enough to have a good fair without the aid of the State, I for one would go without a fair. We have built a building, and paid for it, and we owe no man a cent.

Mr. HINMAN. "Honor to whom honor is due." There is no doubt that many of these local societies have been very well conducted. The animals and articles for exhibition embraced in a small circle can be got together at local fairs very easily, and the people can see them at a very little expense. I don't know but some gentlemen will consider that I am a little tender on the horse question. I never have had any thing to do with trotting horses, but I believe the horse men are more grossly misrepresented than any other class of men. They pay ten per cent. on the amount of premiums offered where they trot for money at a fair, instead of paying twenty-five cents for admission, and in many cases they pay more than the entire premiums offered, and trot for only a portion of their own money. Neither the State nor the agricultural society puts in a penny. I believe in "giving the devil his due," and not harping too much upon the money that they take out of the treasuries of the societies, when the fact is, that instead of taking money out they sometimes put it in. They certainly, in many cases, draw a great many people to our fairs, who would otherwise never visit them, and so lose the opportunity for improvement. There is something in that.

Adjourned to 2 P. M.

AFTERNOON SESSION.

The Convention re-assembled at 2 o'clock, Vice-President HYDE in the chair, and the following paper was read by the Secretary.

THE PRESERVATION OF FOOD.

BY T. S. GOLD.

It is not my purpose to present an elaborate essay upon the different methods of preserving food which are employed in the commercial world, but briefly to refer to the principles involved, and to their application to our domestic wants. To give in detail the methods by which meat, vegetables, and fruits are preserved or cured, so that they can be kept indefinitely and transported to all parts of the world, either in the fresh or cured condition, thus depriving the seasons of their peculiarities as furnishing *seasonable* fruits and vegetables, and climates even of their monopoly of their productions, would of itself occupy more space than can be devoted to the record of this whole meeting which, while it is not designed by any means to embrace the whole subject of food, yet, as far as time will admit, there will be presented by the best authorities those considerations which should control our selection of food and its preparation for the table.

TEMPERATURE,

and the degree of moisture in the air are among the most important conditions in the preservation of food. Both heat and cold may be used in staying decomposition, or may hasten it, according to degree. All substances used as food either contain within themselves the germs which lead to their destruction, or insect enemies are at hand ready to consume them. Guarding against one difficulty we often encounter another equally serious. How we may best use some of these agencies for our protection, it will be our object to set forth in this paper. To temperature and atmospheric influence add certain chemicals, and the whole ground of preserving food will be covered.

The preservative or antiseptic qualities of common salt have long been known, and as it is cheap, harmless, and generally palatable, it is in universal use for preserving fish, flesh, and other animal products. Sugar, saltpetre, and borax are used to some extent, as well as several gaseous compounds, but it is not our purpose to enter into an examination of any of the special processes that have been invented, but rather make this paper a reminder of what we all know, and thus help us better to use this knowledge.

Cold is the common and obvious method of keeping raw meat fresh, free from change or putrefaction. By applying this principle, fresh meat is transported in refrigerator cars from Chicago to our eastern markets, or even carried across the Atlantic, and pork and beef can be salted so as to cure perfectly even in the summer season or in warm climates. By this means the white fish of our western lakes are preserved fresh and transported to distant markets. The fish packed in tin boxes are surrounded with a freezing mixture of pounded ice and salt, producing a zero temperature. They are then kept in a frozen state till needed for the table.

RIPENING OF MEAT.

It is a well known fact that flesh of all kinds, notably venison, mutton, and beef, in order to be in the best condition for the table needs to undergo a ripening process. It should be hung a week or more in a moderate temperature a little above freezing. This is readily accomplished in preparing meat for the city markets even in the summer season, yet is rarely attempted by our country butchers. For this reason our country butchers' meat is inferior to that served in the cities, as well as for another, that the larger and more matu animals go to the city markets.

We consider as an artificial taste that which requires game to hang and ripen till only an epicure or an Indian can endure it, but all meat becomes tenderer, requires less cooking, and loses much of the animal odor or taste by keeping a proper length of time, depending upon the temperature. Veal and lamb need this less than the flesh of older animals.

For ordinary purposes, meat should not freeze. Pork should be cooled to near the freezing point and may be cut up in one or two days for packing, yet the hams if well cooled will improve by more delay. For home use, split the hogs soon after killing and take out the lard, as the latter is then done more easily, and cooling is facilitated.

Beef will ripen better in the quarter than if cut up, and should hang a week or more in a cool atmosphere. In warm weather, if it is to be salted, attend to it as soon as cool, for the danger of flies and taint will not admit of delay. The eggs of the flies if laid on the meat will hatch and grow even in strong brine. Otherwise delay the salting till the meat has arrived at its best condition. Frozen meat will not take salt well, so it must not be salted when frozen or kept at a very low temperature till perfectly cured.

Beef tongues are particularly liable to taint, and in hot weather the safest way is to boil immediately. Put the tongue in hot water with plenty of salt, and cook till tender, and there is no better lunch.

Meat that has fully ripened by keeping, for cooking should be put into hot water or a hot oven. Slow cooking will allow the interior of a large joint to remain at a temperature favorable to decomposition for a long time, and taint may occur. The soundness of a piece of flesh may be extended for some days by rubbing it carefully with fine salt, as much as would season it, or, better still, pour on boiling water so as to thoroughly scald the surface, and then rub on salt.

The rough, scraggy, bloody parts of meat are most liable to taint; use these first. A leg of veal or mutton cut from the bone may be kept as above described for a week, even in warm weather, without the aid of ice.

Slaughter towards evening, so that the flesh may have a chance to cool. The animal should be quiet, no unnecessary driving or excitement to heat the blood. Hang the meat out in the night air and in a dark, cool cellar in the daytime, or place it in the pork barrel with a tight-fitting cover. Scalding the surface by killing any germs of decay gives a new lease of life. Keeping meat by aid of ice is more easy. Place in a clean box and pack among the ice in the ice-house, or keep in a refrigerator, *always* supplied with plenty of ice.

To those favored with the daily visits of the butcher's cart these precautions would seem unnecessary, but farmers are seldom so situated. They must rely on their own resources. Meat that has been kept on ice, or carried in the butcher's cart when the mercury is in the neighborhood of 90°, is not the proper material to experiment on, but take that of your own slaughtering and you can rely upon it.

For salt pork, pack only the solid fat portions; the lean is better for sausages and for eating fresh. Cut the pork in strips of four or five inches wide and pack edgewise in sweet barrels, using abundance of salt on the bottom and top and between the layers. Add cold water or a saturated brine to cover the meat. This should always cover the meat, and some undissolved salt should be above the brine. This is less necessary where it is disturbed by almost daily use. We have never had any trouble about keeping pork from which we frequently used, but when we have had barrels standing for some time we have had a moldy scum on top of the brine and rusty pork. Frequent moving of the barrels is a good preventive.

HAMS

may be cured by rubbing small ones once or twice, large ones repeatedly for six weeks with a mixture of salt, molasses, sugar, and saltpeter. The latter should not exceed four ounces to the hundred pounds of meat, as we do not want its medicinal effects.

For convenience we prefer to use the following recipe: rub the hams carefully with fine salt and let them lie three days to drain; then pack in a clean barrel and cover with brine made as follows for one hundred pounds of meat: water six gallons, salt nine pounds, molasses one quart, sugar two pounds, saleratus two ounces, saltpeter four ounces; boil and skim, and when cold pour on the meat; use a flat stone to keep the meat from floating. In three weeks take up the meat and repack, and in three weeks more, unless the hams are very large, they will be ready for smoking.

When taken up for smoking, wash off the brine and hang to dry for a few days in a dry kitchen; then smoke with hickory chips and cobs to a chestnut brown, in degree according to fancy. It is a good plan to rub the hams before drying with red or black pepper. Avoid too great heat from the fire, but the hams should not freeze while smoking; indeed, freezing at any time injures them, making them dry and hard.

IN KEEPING HAMS

we have to contend with flies making maggots, with the black or spotted bug, *Dermestes lardarius* of Linnæus—that is in another form a hairy worm, sometimes called "bacon-beetle" or "dried-beef bug," and is as great a pest in natural history objects as it can be anywhere, and with mold. Some succeed in keeping them in one way and some in another, and some fail. We enumerate some of the different methods practiced. Let them hang in a dark smoke-house, and make an occasional smoke. The bugs get into my smoke-house, and seem to like the odor of smoke.—Hang them in a tight closet in the upper and interior part of the house. The bugs have always found our closet.—Pack in oats in places exempt from the bug.—Wrap in newspapers, and bury in dry ashes. In this way we have suffered from mold.—Pack in fine salt in barrels or boxes, and keep in a dry place. If kept dry they will not absorb salt, or mold, and insects will not attack them.—Use rather a long string for the ham, suspended in a loose bag made of firm cotton cloth, or in a paper flour-bag, the bag being tied tightly around the string of the ham, which should be hung from the rafters of a well-ventilated garret. This proves a perfect success, provided the bags are tight and tied closely around the string, and the mice cannot get at the bags.

Mr. William Crozier recommends oatmeal as the material for packing. Rub thoroughly with it, and pack so as to cover completely. Our success with any one method has not been so complete as to prevent us from seeking out and trying new methods that promise well.

FOR CORNED BEEF AND DRIED BEEF

rub with fine salt, and use same pickle as for hams. Any bloody pieces should be first soaked in water. Dried beef should be treated the same as hams, only rely more upon drying and less upon smoking. To keep the corned beef in warm weather, scald the brine occasionally, adding a little more salt and saleratus, and skim. Add the saleratus before heating the brine. If it is desired to freshen the corned beef, use an abundance of water in boiling, or change it, or soak over night. Beef and hams thus cured will be found tender and sweet, and not too salt for most tastes.

If meat is frozen and kept so continuously, it does not seem to be much injured. Allow beef, pork, or poultry to freeze solid, and pack in a barrel, and cover with several thicknesses of blankets, so that it shall not be affected by changes in the weather; or, when thus frozen, pack in clean, dry snow, and cover with blankets or straw. It will keep perfectly till there comes a decided thaw. When desired for use, draw out the frost by immersion in cold water. A ten pound roast will require some twelve hours to extract the frost.

The humidity or dryness of the atmosphere has much influence on the keeping of meat. Jerked beef is prepared by cutting the meat into thin strips, and drying in the air. In some climates it is a success.

In our attempts to keep meat fresh, we should avail ourselves of all favorable conditions to secure our object, and avoid those that are unfavorable. We have spoken before of scalding the surface of raw meat to help its keeping. Thorough scalding, clear through, will give a new lease of life to meat that has been cooked. This may be repeated if it is desirable to keep it a long time, but you cannot thus well reach the center of a large joint. You must cut it up, and this must be done before any taint appears. In extreme cases, where meat has begun to taint, it may be restored by boiling with pieces of fresh burned charcoal tied up in a bag; but it is better to avoid this necessity.

SAUSAGES

should be made of due proportions of the firm parts of the fat pork and of the lean that is free from tendons and stringy, skinny, bloody portions. Good meat alone is used in Burnett's celebrated sausages, and in the best households; what may be the constituents of the commercial article we cannot tell. Here we may truly say,

> "If ignorance is bliss,
> 'Tis folly to be wise."

Sausage meat, after it is chopped fine, should be seasoned with salt, one-half ounce to the pound of meat, and black pepper to the taste. Some add sage or summer savory, but these seasonings render them more difficult of digestion. We have tried preserving the sausage meat in skins, in cloth bags about four inches in diameter, also packed in common tin pans and covered with melted lard. The meat is cut in slices for cooking. We give the preference to the last method. Sausage packed in skins may be kept a long time by partial cooking and packing in melted lard. Indeed, ham is sometimes sliced, partly cooked, and kept in lard.

CANNED MEAT, FISH, ETC.,

are thoroughly cooked in tin cans and sealed up while hot. The contents of the cans contract on cooling, and the settling in of the ends indicates that the work is perfect, the cans are air-tight, and the preservation of this shape proves that no decomposition has taken place.

A RAT-PROOF GRANARY OR CORN-HOUSE

would be a great desideratum in preserving grain. These are easily planned, but the difficulty lies in the construction. From the time the grain goes into the barn, vermin, large and small, infest it. Cats and dogs, traps and poison, are all employed to keep the vermin in check—they are never exterminated. They move into your new barn as soon as the first load of grain goes in, and fresh colonies arrive to take the place of those destroyed. Cleanliness in removing all old grain from the bins will help against depredations of insects, and removing the hay and straw in summer will banish the rats.

The smaller grains should be so thoroughly dried before storing in the barn that no must will appear in the grain or straw, and if they are not threshed till cool weather, they may be safely stored in any clean, dry bins or barrels, but Indian corn requires longer curing, and must be kept on ventilated floors or in bins with proper ventilation. Stored in tight barrels or bins, either in the ear or shelled, it is liable to mold, at least so as to have a musty smell and the meal to have a bitter taste.

The peculiar excellence of our Indian corn can never be enjoyed except when clean, sound, well-ripened ears are selected that have never been rat-infested, carefully shelled, and freshly ground, and then, what is more appetizing than a good hasty pudding or johnny cake? and who can appreciate it better, and who is better entitled to enjoy the feast, than the boy who has worked and watched the corn from planting through hoeing to harvesting the golden ears, driven team and rode horse to plow? for he has honestly earned it by his labor, and though for a time the seeming luxuries of the city, with its activities, may lure him from the farm, yet will the memory of these labors accomplished and delights enjoyed ever prove a strong power to draw him back again to that employment, where he can earn his living by the labor of his own hands—an independence higher than that of wealth.

Indian meal, unless made of old corn, cannot be kept in any large quantity; in fact, even in barrels or bags it is liable to heat, cake, and become sour and moldy. For table use it should be fresh ground and spread on sheets or papers. Even old corn or meal from the same cannot be safely stored in large bulk. Flour should be kept in tight barrels, but avoid holding large quantities through summer heat, and store in a dry place.

BUTTER.

Butter is packed in sealed packages for distant transportation, especially to warm climates. Good butter, made in June, when it is usually the cheapest, may be preserved most conveniently by wrapping each roll of about four pounds in a clean cloth, and packing in a clean barrel or stone jar; cover with brine saturated with pure salt, and if sound, it will keep so for the year. It loses the taste of fresh buttermilk, but does not become rancid or absorb any additional salt. Pure salt is essential for long-keeping butter. Saltpeter and sugar are sometimes added. There is nothing more susceptible to all odors than milk, cream, and butter. A moldy cellar, with strong-smelling and decaying vegetables, is no place to keep butter. The wood of tight firkins in such a place becomes permeated with the moldy smells, and how much more will the butter lose its nice, rosy flavor when it is opened where fish, hams, and onions each claim their share of our notice? We smell them all in the farmer's cellar, and in the grocery add kerosene and tobacco. It is a life study for any one to learn how to make and keep A No. 1, gilt-edged butter, and you cannot expect me here to give the precautions needed to secure this result. The cow, her feed, her health, the weather, the manipulations, every surrounding of the operation, may help or mar the product, and we are not surprised that the man who can guarantee a uniformly good article has the market to himself and controls the price.

Little thought is bestowed on keeping milk for drinking or for cooking, but the remarks upon the absorption of odors by butter are equally applicable to cream and milk. Milk standing in a dusty, smoky kitchen is as unfit for drinking as for butter making, and the cream pot kept in a moldy cellar will exchange the fragrance of new-mown hay and clover blossoms for the dank smells of rotten wood and decaying vegetables. The germs of contagious diseases have too often been traced to the milk to suppose that they have not been sometimes introduced by atmospheric influences.

VEGETABLES

of different kinds, while in the main requiring the same conditions—a cool, even temperature above frost—allow of some variations. Potatoes should be dug in dry weather, and soon as dry may be stored in barrels or bins in a dark cellar, where there is no danger of freezing. In any ordinary quantity needed for a family this is just as safe as to spread them in sheds till cool weather, and their quality is injured by any extra exposure to air or light. A dry cellar is usually advised, but I have no experience with one that does not have water flowing through its drains continually, but is kept well ventilated by open windows till severe weather, and then by the draft of a furnace. We have never had any rot in potatoes caused by a few bushels put in wet, but we prefer that they should be dry—and cool. They may be dug any time after the tops are dead and the potatoes are ripe, so that the skin will not slip in handling.

Beets for the table should be harvested before severe frosts, placed in barrels, and covered with sand in the cellar. Carrots may be dug later, and kept in the same way.

Common field turnips are improved in flavor by moderate frosts, but lose in keeping quality. White French or sweet turnips will bear a frost of 25 degrees, but are not benefited by so severe cold.

Onions are stored in large quantities in barns in narrow, well-ventilated bins, covered with hay in extreme weather, but are not injured by a little frost; but for family use we would keep these and all the others mentioned in a cool cellar, but exempt from frost.

Parsnips may remain in the ground all winter and be dug for use in the spring; but this shortens the season for a very choice vegetable. Dig a part of the crop, and store in the cellar, and use after January. They are much better then than earlier.

Celery may be kept in small quantities in boxes or barrels in the cellar. Earth should be kept on the roots, the tops trimmed and the plants placed upright, not too closely. Sand, moss, or leaves may be used to pack between the stalks to prevent drying and frost. If the cellar is too dry and warm, for a small quantity sink a barrel in the ground, fill with celery, standing upright, and cover with leaves or straw from severe frost. Also it may be packed upright in trenches, where the drainage is perfect, and covered with earth, then leaves and manure to exclude severe frost.

THE PRESERVATION OF FRUIT

requires a cool, dry air, but this rule admits many modifications. If the air is too dry the fruit will shrivel and loose flavor. Pears will not endure the same cold as apples. Winter pears will rarely ripen up well in a cellar; they will decay without ripening. Pears should be picked when moderately cool—for autumn as well as winter use. To ripen for eating, place them in shallow drawers, between flannel blankets, in a common living room; the higher the temperature the more rapidly they well mature, and within certain limits with finer flavor. But if the weather has been cold and wet, the soil poor and the trees overloaded, and the foliage dropped, all our attempts to ripen up the fruit so that it will be first-rate will fail; but with good culture and proper care every month in the winter may have luscious pears in succession.

Apples, after all, are the fruit for all seasons. Reasonable care will furnish them in perfection for the whole twelve months.

For long keeping, pick carefully only sound fruit, in dry, cool weather, and place directly in clean barrels. These should be kept in the barn or some other out-building till in danger of freezing, and then be removed to the cellar.

We do not head up the barrels, but place a second tier of earlier kinds as covers to the lower tier. Thus they can be readily reached for examination or use, and the fruit is not bruised by pressure. Have wire cloth screens to the windows, and use the glass only in extreme weather. Apples should never freeze, but should always be kept cool. No strong smelling vegetables or other substances should be allowed in a fruit cellar. The delicate flavor of a pearmain or a seek-no-farther is readily exchanged for that of decaying onions or cabbages. In a clean, sweet, cool, well-ventilated cellar the different varieties of winter apples will come into perfection, month by month, till the new crop, with its freshness and piquancy, though coupled with greenness, crowds them off.

We omit a description of fruit houses, where, by the proper use of ice, large quantities of fruit may be kept for market. The process is successful if rightly managed. We seek similar results by simpler means.

We refer to the acconnt of the fruit house of Mr. Milesof Milford, contained in the report of the Board for 1878, for an example of success.

PRESERVED FRUITS

may be prepared by cooking and sealing while hot in glass jars with little sugar. To have the best, the fruits themselves must be in perfection, ripe but sound. The delicate aroma of the raspberry or strawberry is gone long before the form and color of the fruit fails. When will men, and women too, learn some things so vital to our health and happiness? With rare exceptions, (I wish I knew how it could be done every time,) where the original fruit and the skill were alike first-class, we have not found this method of preserving fruit as satisfactory as the old one of preserving in sugar, jellies and fruits pound for pound, or near that, according to the acidity of the fruit.

Thus preserved, quinces, green gages, damsons, Clark's or Brinkle's orange raspberries, and strawberries, have held their delights for the palate in perfection, and you can do no better. As these are designed to give pleasure in eating, and not as medicine, always aim to have them good, not mere substitutes for something good. Of these substitutes we have found dried currants stewed in molasses, dried sweet apples stewed, dried blackberries or whortleberries stewed without even a touch of molasses; but we forbear to continue the list.

In conclusion, we would say that it is not too difficult a matter for every farmer to have a full supply of meat, vegetables, and fruit, each and all in perfection, fresh or properly preserved or cured, running through the whole year, and all, too, of his own raising; and a homestead so provided has little to fear from western competition.

The CHAIRMAN. The programme announces that at three o'clock a paper on "Cream as Food" will be presented by O. S. Bliss of Georgia, Vt. Mr. Bliss was in attendance at the fair in New York last week, and has written that he is tired, exhausted, and has gone home sick, hence we shall not be able to present him as one of the speakers. The rest of the afternoon I hope will be used in discussion and asking questions, if any suggest themselves to you, of the gentleman who has just addressed you. I take this early opportunity, also, to say that this evening there will be a paper read upon "Home Supplies of Food," by J. B. Olcott, the agricultural editor of the Hartford *Courant*. I presume most of you have read his articles in that paper; if you have not, you ought to have done so. If you neglect the opportunity to hear him this evening you will certainly lose a feast of fat things. Any questions will now be in order to the gentleman who has just addressed you.

Mr. FISH of Mystic. I would like to ask Mr. Gold if he can tell us how to preserve hens' eggs fresh?

Mr. GOLD. For family use, sound eggs can be preserved perfectly by packing them in lime-water, to which you may add a little salt or not as you please. Take whitewash and add more water to it, pack your eggs in stone jars that will not leak, setting the eggs on end, cover them with this lime-water, and place them in the cellar where they will not freeze, and for all purposes for use in the family they will keep perfectly good for months, perhaps years. That, I believe, is the practice of market-men, who pack large quantities of eggs in that way in the cities to meet unusual demands; but the farmers have a great advantage over the market-men in this respect; they can pack what are called "farmers' eggs," and they will keep a great deal better than the city eggs.

Mr. MORRISON of Willington. I would like to ask if there is any difference in cellars in respect to keeping butter, where they are equally clean and kept perfectly pure and sweet? Does the soil have any effect on butter?

Mr. GOLD. There is a very great difference in the temperature of different cellars, owing to the character of the soil and the depth to which they have been excavated, so that there would naturally be a difference; but whether there is any difference between a sandy and a clayey soil in the respect to which the gentleman refers, I cannot say. Have you a cellar that will not keep butter?

Mr. Morrison. We have a cellar, and have lost some butter, or nearly lost it, by its becoming strong, and we concluded when we put down June butter, it would be better to carry it to our neighbors' cellars if we wanted to keep it any length of time. I know of several cellars in which butter can be kept better than in others. I attribute it to the character of the soil, not to want of ventilation, decaying matter, or anything of the kind.

Mr. Gold. What is the nature of the soil?

Mr. Morrison. I can hardly tell you. I live among the rocks of Willington, a real granite place, and the soil where I am situated is very excellent for all the crops I want to plant.

Mr. Hart of Cornwall. How strong should brine be for the best preservation of butter that is made in June?

Mr. Gold. I recommend a saturated solution; then you are sure of the article that you have got, and I believe there is no objection to a saturated solution. Mr. Hart, I think, has made some experiments, perhaps more definite than mine, in that direction, and he can give us his views on the subject.

Mr. Hart. I put down several barrels of butter in June in the way that Mr. Gold describes in his paper. The first two barrels were salted a certain quantity of salt to a certain quantity of butter, and a not very strong brine was put upon it. I found, when I came to take up this butter for examination, after a month or two, that the brine had extracted the saltness from the butter, and further experiments taught me that the brine should be made about as strong as it can be, or else it will extract the saltness from the butter. In that way butter will keep very well, and can be put on the market at any time when the price calls for it.

Question. Will the butter increase its saltness by being immersed in strong brine?

Mr. Hart. I have not found it so at all. It will not.

Mr. Augur of Middlefield. I find that there is a great difference among butter-makers as to the amount of salt that they use in salting their butter. Our rule has been one ounce to the pound, but I have found that some customers want more and some less. I would like to inquire of Mr. Gold what has been his practice as to the amount of salt in salting butter, and where butter is to be kept for winter use, how much salt he would advise?

Mr. HART. As Mr. Augur has stated, different customers want different degrees of saltness in their butter. I have found that it keeps best to put in an ounce to a pound, and it meets the tastes of perhaps a majority of the middle classes. The high-toned customers want their butter with less salt in it, perhaps one ounce to twenty ounces, and I apprehend that that is about the degree of saltness for gilt-edged butter. I will say an ounce of salt to from eighteen to twenty ounces for gilt-edged butter; that brings the highest price in the New York market. There is a great deal of butter sold in New York without any salt in it, which brings a good price.

This question of preserving butter is one of great importance to the dairy interests of Connecticut. The latter part of May, June, and the early part of July, a great deal of butter that was made in this State, particularly in the western part, was sold for from eight to fourteen cents a pound; some more, and some, I am sorry to say, for even less than that; but the average range was between those figures. Now, if we can prepare our butter by means that are within our reach, so as to preserve it until less is made and the market demands the article, so that it brings a higher price, it becomes very important to know how this can be done. Butter that was made at the time I speak of has been sold since for a very handsome advance, one hundred per cent. or more, just for preserving it. The Connecticut market is receiving from week to week, now, butter that was made in New York State and in the western States at the same time with the butter that was sold at such low prices, and paying more than double what the farmers got for butter made at that time. I know this to be the fact. Now, the question is, how can we preserve it? In the first place, as Mr. Gold remarked in his paper, the initial step, the feed, must be right, the careful management of the cow, and cleanliness in every step. There should be no acidity to the milk until the cream is extracted, and the cream should be extracted as soon as it can be. Then it should be churned at the right time, when the cream is ripe for churning. Then it should be kept from exposure after it has been churned until it is put into air-tight packages, or into brine, or in whatever way you propose to preserve it, and kept in an even temperature, as low as it can be conveniently kept; and then it may be put upon the market at any time when it will bring the best price.

Mr. A. W. CHEEVER, editor of the *N. E. Farmer*. One word in respect to the matter of keeping butter. I have not heard it mentioned that in pickling butter, or putting it down in brine, it should always be kept under cover. This is just as essential as that pork be kept under brine entirely while being preserved. If we put rolls of butter in cloths and pack it in brine, and let a portion of it float on top of the brine, that part which comes to the surface will spoil just as though it were not near brine, and the spoiled butter will spoil the brine, and so the taint works through. It is absolutely necessary in keeping butter to keep it under the brine all the time, not even let little crumbs float. It does not answer to let crumbs of pork float on top of a pork-barrel. They must be kept off.

Another word in regard to a little slip that I have seen going through the newspapers giving an account of an accidental discovery of an excellent method of keeping butter. By some mishap a pail of butter hung in a well was forgotten for a long time—I won't say just how long—and the papers keep passing the statement round, week after week, month after month, that that butter was found at the end of a long time perfectly sweet and good; and so people are advised to preserve their butter by sinking it in common wells, in cold water, in tin pails. I had occasion last summer to be present at the opening of a box of butter that had been sunk in cold water, and I must say that it came up spoiled; and I would not advise any one, on the strength of newspaper articles that they may see of that character, to put any of their butter into a well of cold water. It was as thoroughly bleached as beeswax is in the sun, or as any substance could be bleached by any process. The butter came out perfectly white, and entirely free from salt for an inch in depth, perhaps, and had a very disagreeable flavor throughout. It is a good thing to know how *not* to do things.

Mr. **Alford**. I have never had much experience in making butter, but I have dealt in it considerable, and have noticed that there is a very large variety in the quality of butter that is brought in from the farms, and I have queried what should cause this difference in quality. I have often inquired of farmers how they managed in the manufacture of their butter, and I have attributed the cause of the difference very largely to their working it with their hands, which dissolves the globules of butter, and gives it a greasy appearance on the surface, and I have come to the conclusion that that is the way in which very much of the butter is spoiled. I have asked the ladies when they brought it in, if it had that greasy appearance, "Didn't you work this with your hands?" "Certainly." Others have said that they worked their butter with a ladle, and I have noticed that the butter worked with a ladle was very much superior to that worked with the hands. If there is any one here who has had any experience, and can give the convention any light on the subject, I hope he will let us have it.

Mr. ——. When the gentleman spoke of the accidental discovery of the method of preserving butter by keeping it in water, I was reminded of an article which I read giving an account of a keg of butter that went down with a vessel, and after fifteen years it was raised and found to be perfectly sweet.

Mr. **Cheever**. May I ask if that was in fresh water?

Mr. ——. No, sir; it was in salt water, but the keg was perfectly water-tight.

Mr. **Whitaker** of Massachusetts. I would like to ask Mr. Cheever if the vessel in which that butter was kept so long was water-tight or not?

Mr. **Cheever.** I should think not. It was perhaps a square confectionery box of clean wood.

Question. I mean the one that was preserved so long according to the newspaper account. Was that in a water-tight box ?

Mr. **Cheever.** I have only read of it as being in a tin pail.

Question. Was the tin pail water-tight ?

Mr. **Cheever.** I suppose not.

Mr. **Whitaker.** All the difference in the world would arise out of the two circumstances. If the pail was water-tight it would keep the water out, and butter would keep for ages in that pail; but if the box in which the butter was placed was not water-tight, it would let in water, and the water would extract the salt from the butter, and also extract the coloring matter and everything that gives taste to the butter, and you would have a tasteless article. A simple change of condition might make all the difference, and in order to come to any conclusion about these things we want to know exactly the conditions. We often stumble because we do not know the precise data. That is essential, and no man of science can know a thing unless he knows all the conditions that enter into the experiment he is making.

I would like to inquire whether salt be essential at all to the keeping of butter ? There has been considerable said about it. In regard to flavoring butter, I will grant that tastes vary according as they are trained on that subject, but I am under the impression that butter free from every foreign article, like buttermilk, keeps just as well without salt as with it, and better, and I should think that the practice of salting butter to keep it would be no more sensible or reasonable than salting lard or tallow to keep either of those articles. Therefore, I think it is a matter of importance to inquire right here if anybody knows whether it be essential to salt butter for the purpose of keeping it. I asked this question three or four years ago at the American Dairymen's Association, and some one called out, "I would like to hear that question answered." I have seen recently an item going the rounds of the papers, (and I suppose my friend who referred to the other newspaper statement has seen the same thing,) to the effect that they have a process in Europe of making butter and keeping it without any salt at all, and that butter is better thus preserved, and is more satisfactory to the consumers. Some of us are aware that in Paris butter is salted at the table the same as steak is. It is prepared and sent into market without any salt at all. I would like to hear the question answered, whether it be necessary to use salt at all in the preservation of butter.

Mr. HINMAN. I am not scientific enough to answer the gentleman's question from a scientific point of view, but it is certain that salt has a chemical effect upon butter which changes its color from a light to a deeper yellow, and it also frees quite an amount of buttermilk, or some other liquid, which butter-makers call "brine," that the ordinary farmer's wife does not know how to get out of her butter in any other way. An ounce of salt applied to a pound of butter and left for a few hours will change that butter to a deep yellow color, and will liberate so much of this "brine" or liquid, which is almost clear, not the color of milk, that the salted butter will weigh less than the fresh butter did. I have frequently heard it mentioned as a fact, that the farmers made something by the salt that they put into their butter; that they bought it very cheap and sold it at the price of butter. But that is an erroneous idea. In our experience we find that salted butter actually weighs less than fresh, and whether the buttermilk could be eliminated thoroughly by any other ordinary process is a question in my mind.

Mr. WHITE. I think that butter can be perfectly freed from brine without salt. Butter-making is a part of my trade on the farm. We calculate to leave the butter entirely free from brine when it is salted. What brine there is in it comes out as clear as crystal before it is worked over the last time. We work our butter with ladles invariably. The moment the butter forms into small particles, about the size of a pea, we draw off the buttermilk, and put in fresh water and churn it up. We work twice or three times, until the last water is as pure when it comes out of the butter as when it went in. Then we salt to taste. We have no trouble in keeping that butter a year, if it is necessary, perfectly sweet. Of course it is old butter, and tastes differently from new-made butter, but there is nothing rancid, nothing strong about it.

As Mr. Gold says, it makes all the difference in the world how butter is manufactured. You must begin with the feed. You cannot make the first quality of butter from a poor cow, or from poor feed. Nor can you make first quality butter, if every thing else is all right, unless your implements are perfectly clean, and the milk and butter kept free from every impurity, until the butter is finally salted. When you get to that point, that butter can be kept, with very little trouble, perfectly sweet, fresh or salt.

There is a difference in cellars about keeping butter. I have two cellars. One is a larger cellar than the other, and the soil is richer, and in very hot summers we have found it difficult to keep butter there. The other cellar has yellow loam on top and a blue clay underneath, that is rather hard to dig with a pick-axe. In that cellar butter has always kept well. If butter is packed in brine, it should always be kept entirely under, no floating particles allowed on top.

QUESTION. I would like to ask the gentleman to give us the best method of getting cream from the milk, after the milk is drawn from the cow.

MR. GOLD. If you ask me, there are so many methods recommended that I shall not pretend to decide the question. I believe that in the most favorable conditions of weather, etc., there has been no means devised by which you can get more cream, for you can get it all, or where you can get better cream, because you can get the best, and that is as good as it can be, than in the old-fashioned shallow-pan setting. But all the most favorable conditions exist but a very small portion of the year. In place of that we have various patent contrivances that are offered us at present for setting the milk and obtaining the cream, by which it is claimed we may overcome the difficulties attendant upon the temperature. You have the Hardin system, developed into the Cooley system, and still further developed into these other systems of setting the milk in deep cans, surrounded with ice cold water, either entirely, or, as in the more recent plans, partially surrounded with ice-water, so as to extract all the cream within twelve hours. You have also the bureau system, in which milk set in shallow pans, by aid of a refrigerating apartment, is cooled down, and the best October temperature is maintained for raising the cream.

All these processes are before the farmers, the agents of each claiming the best, and we are not prepared to decide between them, but, considering the difficulties of controlling the temperature, I am quite sure that any one of those processes is vastly superior to the old system of setting in shallow pans, and that it will pay every farmer to adopt some one of these improved processes. I will not pretend to decide, at present, which is the best method.

As that question has been raised here, I would throw out a suggestion. The State Board of Agriculture have been urged to institute a series of experiments to test this very question.

Now it is probable that the farmers of this State in the next five years will expend at least $100,000 on new dairy apparatus. I am confident that they will, such is the spirit prevailing to adopt these new processes, and, as I say, we are urged by certain parties to institute a series of elaborate experiments, running through the year, to test the amount and the quality of butter obtained from milk by these different processes; to test its keeping qualities, also its market value, and every thing connected with this subject that hinges upon the different methods of setting milk. The Experiment Station is ready to undertake its share in examining the salt, and all the materials that shall be employed in the manufacture, as coloring matter, and to test also the resulting products—the purity of the butter, the buttermilk, the skim milk, and the whey; and unitedly to attempt to settle this question, and show by which process you can get the most, that is, all of the butter particles, and with the least labor, and in the best possible condition. If we do not consider that it will cost too much, and entail too much labor, we possibly may undertake such a series of experiments. Perhaps it is premature to speak of it here, but as I have had as much personal talking to do on the subject as any one, I feel perfectly at liberty to explain it to this audience.

Mr. WETHERELL of Boston. I would like to inquire of the secretary whether he has any knowledge of what is called the centrifugal system of separating cream from milk practised by Mr. Burnett?

Mr. GOLD. All I know is, that Mr. Burnett successfully separates cream in that way, but I understand that he does not anticipate that this will ever become a common process in actual work. The amount of machinery and the complication of the process is too great for any general application of that principle. While it is a success carried on as an experiment by Mr. Burnett, it would not be a very safe example for common farmers to follow.

Mr. WHITAKER. I had a conversation with Mr. Burnett about his method of extracting cream by centrifugal force, or, as he termed it, "artificial gravitation." He stated, in some remarks that he made at the last meeting of the Massachusetts Board of Agriculture at Greenfield, that he had extracted water from butter by the operation of the machine. He placed the butter in the same basket which he used for obtaining the cream from the milk, set it in motion, and found that the water was thrown out, and that the butter came out a solid mass. When Mr. Burnett left the platform I asked him if he had ever been in a woolen factory. He said he had, and, he says, "I must say that was where I got my idea." I said, "That is exactly the same machine which woolen manufacturers use in extracting the water from wool. After the wool has been scoured and washed it is very wet, and, a few years ago, finding it took so much fuel to expel the water, some means were sought by which it could be done cheaper and quicker, and the plan was devised of placing a basket inside a large cast iron bowl, which, set on a very small pivot, makes two thousand or more revolutions a minute, and the water is quickly thrown out, and the wool lies close against the sides of the basket." I saw the Rev. Mr. Bond afterwards, who has a smaller machine of the same kind, and asked him if it was a new invention. He said, "It is not. It is probably a German invention. I have been trying to get a patent for it, but all I can get a patent on is simply the method in which I get the milk into the vessel and out of it."

Mr. **Hart**. Those of us who were present at the International Fair will remember seeing a machine of this kind, and I spent a part of several days there examining the various processes of extracting cream from milk. The machine that was in operation there had flanges within the basket, so that the milk actually revolved with the machine, and the theory of the gentleman in charge, who was, I think, the inventor, was that the heavier particles, in its rapid revolution, had a tendency to fly off from the center, and the lighter particles to approach the center. In its practical operation the cream came out of the faucets quite at the top of the basket, and the skim milk just a trifle below where the cream ran out. The result, when they had obtained the cream, was very satisfactory. The cream was very fine, I thought.

But I wanted to answer the question which has been asked —"Will butter keep without salt?" I have manufactured it and dealt in it more or less for twenty-five years. I don't think it will keep any length of time unless it is prepared as the Germans prepare it, which is by cooking. Unless your lard is cooked it will not keep. Unless your butter is cooked it will not keep without salt. That is my experience. It must be made and put upon the market and consumed within a short period of time.

Now the great question that interests the dairymen of Connecticut is, how shall we compete with the west? They are driving us out of our own markets; they are taking all the premiums away to the far west. How shall we compete with them? Shall we do it by acting upon the maxim, "Every man for himself," with no uniformity in the product, and with no special market for which it is made, or shall there be co-operation, by which we shall be able to put enough into central points to make an article that is sufficient in quantity, and of such uniformly good quality as to establish a name and a market? I think it is a disgrace to the farmers of Connecticut that so large an amount of the butter consumed in this State is made in the far west. Your best hotels are supplied with butter made in Wisconsin, Minnesota, and Iowa. The farmers of Connecticut cannot get that market, because they do not make the article that the hotels want. It is not good enough the year round. There are certain seasons of the year, when the conditions of temperature are right, that they make some very good butter, but when August comes what are they going to do? They cannot make good butter. I say, if the farmers of Connecticut will go into the co-operative system of dairying, they may retain their own market, and not only supply their own State, but also supply the New York market.

The suggestion of Mr. Gold is an important one. How the thing can be done to the best advantage is a difficult matter to demonstrate.

There is one other thought. If farmers will not co-operate, then it is astonishing to me that they will not provide conveniences for making a better article themselves. Why will they not provide ice-houses for the preservation of their food and the care of their milk? An ice-house is very cheaply built. Every farmer in the State of Connecticut may have one, and then he may have his meat fresh the year round; he may have his butter, his cream, and his milk just as he wants it, and in the most satisfactory condition.

QUESTION. I would like to inquire whether the milk the gentleman speaks of was put into the machine when warm or cold?

Mr. HART. It was cold, but it was claimed by the inventor that it would work better if the milk was warm from the cow.

Mr. WETHERELL. I would like to inqnire of Mr. Hart which he thinks is the better course for the Connecticut farmer, to make butter from his milk, or sell his milk by the can? I ask this question because the statement in regard to the sale of milk in England is, that the farmers who sell their milk make more money than those who manufacture it, either into butter or cheese. As Mr. Hart has had a great deal of experience in handling milk, I would like to ask him which he considers the best course for Connecticut farmers to pursue, to manufacture butter or sell milk?

There is not a farmer's wife in the State of Connecticut who ever made any poor butter! That is a settled fact! The same is true of Massachusetts. But somehow or other, in Boston and New York, about three-quarters of all the butter that gets into those markets is found to be very bad, judged by the taste. Now, as nobody makes any bad butter, it might be a puzzle to know how it gets there.

Mr. **Hart**. I recommend them to supply themselves with facilities so that they can do either, according as one or the other pays best. There are certain seasons of the year when milk is not wanted; when, if it goes to New York, it is sold for the freight, and sometimes dumped into the sewer, because you cannot even give away a can of milk there in June. Now, if the dozen farmers who sent their milk there had established a creamery, where they could put their milk and manufacture butter when the market of New York did not want it, and when the market did want it send it there, they would be in a position to dispose of their product to the best advantage.

Mr. **Day** of Brooklyn. Is not this matter of making poor butter a question which can be very easily solved? It is my pleasure to have been through the State considerably, and I have visited some of the best dairies in the State. Who does not know that Dr. Grant of Enfield makes some of the finest butter in the State of Connecticut? And who does not know that Mr. Starr of Litchfield also makes what is known as "gilt-edged butter"? And it is really and truly so. The reason of it is this: that Dr. Grant and Mr. Starr have the most complete arrangements for keeping their milk perfectly sweet and clean, and the whole process, from the milking to the manufacture of the butter and marketing it, is conducted in the most perfect way. Every one who knows anything about Dr. Grant's dairy knows that he sets his milk after the deep-can system; that his milk is lowered into a spring that is perfectly pure and clean; not the smallest taint or smell or anything of the kind is around the cream; it is carefully churned, and all the buttermilk is extracted that can be with a ladle, and any water or moisture that remains is dried up with a sponge.

Our friend Wetherell says that no farmer's wife ever made any poor butter. I am very sure the women are not to blame because the butter is not always good. Only give them a chance to keep their milk in a sweet, clean place, away from the odors of the sink and of the kitchen, and carry the milk into them sweet and clean, I will warrant you they will make butter that any gentleman will be willing to eat.

Mr. Hart made one suggestion which he did not fully explain, and I wish it might be brought out. He said that cream should be churned when it was ripe. It occurred to me when one gentleman spoke of butter being made oily by the use of the hands in making, that perhaps the trouble was that the cream was not churned at the proper time. I want to ask Mr. Hart what he considers ripe cream? It strikes me that the character of butter is very much influenced by the time that the cream is churned. Some butter-makers will keep their cream until it is three or four days old, or more, by putting it into a stone pot or other vessel, adding a little salt, and stirring it occasionally. Now, as Mr. Hart has handled so much milk, cream, and butter, I want to know the precise time that the cream is ripe, and just when it should be churned?

Mr. Perkins. I should like to ask Mr. Hinman, as the lawyers put it, if he actually knows, "of his own knowledge," that if he has one pound of butter and adds an ounce of salt, and thoroughly works it, the butter weighs less than it did before the salt was added? If he "knows of his own knowledge." What he guesses at we don't want.

Mr. Hinman. The point I made was, that an ounce of salt could be added to a pound of butter, and the amount of brine that would be eliminated would over-balance the salt, and that the salted butter would actually weigh less than the butter did in the first place. He asks me if I know that "of my own knowledge." I make that statement, and yet, if I had to hold up my hand and swear in court I should have to say "my mother" told me so. But I want to say, still further, that being called upon to supply families with first-class butter, salted to their taste, I manufactured, as I could not buy cheaply of the form I wanted, a pair of scales that weigh within half an ounce, and every pound of butter we manufacture is weighed when ready for salting, and the necessary amount of salt added; it stands a certain number of hours (I don't know just how many), and it is then worked over, re-weighed and sold, and while I have not been through it myself, I have watched the process very closely, and my mother tells me that the butter weighs less after the salting and working than it did before she salted it at all.

Mr. Perkins. I have my doubts whether, by the addition of salt, we reduce the weight of the butter. I should want to see it in the scales before I believed it.

Now, in regard to our friend Day, who would like to have our common farmers imitate fancy farmers like Dr. Grant and Mr. Starr, it is not fair or just to expect our ordinary farmers, who are working to support their families and pay their debts, and doing the best they can with limited means, to do what these men do. Look at their circumstances. Mr. Starr has capital to do with, made in the city of Philadelphia, and I doubt to-day whether, if his estate were settled, an inventory of the property would show a larger per cent. of profit on the investment than we ordinary farmers make on our small farms. Look at the *Country Gentleman* two years ago. What did it cost to advertise that stock? It is not the money he makes on butter, though he gets a dollar a pound for it from certain families in New York, but when he sells his calves for five hundred dollars apiece, there is where he makes his money, if he makes it at all. It is not every farmer who can afford to have the luxury of a marble wash-bowl in his barn for his hired men to wash in. Take Dr. Grant. He has fine stock, but where did he get his money to buy his fine stock? Not on the farm, but in the practice of his profession for forty years. We cannot apply our means in the same way. Mr. Cheever, if we may credit the papers, makes equally good butter from his polled cows as Mr. Starr from his Jerseys.

Mr. Day. The gentleman speaks of Dr. Grant's circumstances, and Mr. Starr's. There certainly is one great fault, of which I am sure that ninety-nine out of a hundred will plead guilty, and that is, that they do not find the wife a proper place to set her milk. Nine-tenths of the farmers in the State of Connecticut keep their cod-fish, their potatoes, and their cabbages in the same place where their wives are obliged to keep their milk, and it has all the smells of the kitchen into the bargain, and perhaps the outlet of the sink is under the pantry window. Now, I am sure of one thing, and that is, that every farmer who keeps four or five cows can afford to keep a dairy room under different and better circumstances than these, and the necessary outlay will be small, and then his butter, if it does not equal Mr. Starr's or Dr. Grant's, will approximate to it, at least. It is for the very reason that these conditions are not under the control of the wife that the butter is not better. I am not exactly a "woman's rights" man, but I stand here to defend them from the imputation of making poor butter when they do the best they can.

Mr. Whitaker. My wife makes the butter; I stand on one side, and sometimes turn the churn ; uses three-quarters of an ounce of salt to a pound of butter. The butter is weighed before the salt is applied, and I have never known her to be able to put on the market as much butter as she weighed before she put the salt to it. I think that most of the gentlemen here who know much about butter will be satisfied that it does not take a great deal of water to be extracted from butter to make up three-quarters of an ounce, and there is some butter-milk that comes out. You will frequently see, when you have fresh butter brought on the table, considerable water in the dish with the butter, and water will accumulate 24 if not 48 hours after the salt has been applied. I think you will find that the difference is so slight that you cannot easily determine whether you had more butter after the salt was applied than before.

There is another thing I want to say here, and that is in regard to ladies working butter by hand, and thus causing it to be oily in appearance. At the meeting of the Massachusetts Board of Agriculture in Greenfield, a few weeks ago, there was a great dairy exhibition, and some of the best farmers, no doubt, in that vicinity, brought in their butter and contended for the premiums. Some creameries also came there with their butter. But there was a gentleman who had three cows, and his wife sent some butter. The milk from which the cream was obtained was set in shallow pans, the cream churned in an old-fashioned churn, and the butter made by hand. That butter took all the first prizes—$85 in money, and not far from $35, I think, in goods. She cleaned them all out, and she didn't do it with any of the modern appliances. She did it simply and fairly with Yankee pluck, Yankee ingenuity, Yankee skill, and Yankee care.

Mr. **Augur**. This matter of butter-making, I think, is one that touches very closely the welfare of the farmers of Connecticut. This forenoon Gov. Andrews spoke very well to us in regard to the matter of depleted farms. He alluded to the town of Colebrook as one of the many towns where the soil had run down, and farming had gone to decay. One thing I believe in reference to the making of butter; it does not reduce the farms. A ton of butter taken off of your farm does not carry off valuable properties with it. If you sell off the corn, the wheat, the hay, or even cheese you reduce your farms, but not by selling butter, provided the skim milk is fed on the farm, as it usually is, I think. That is my point. If you will think of it a moment, you will see that I am right. Butter is almost all carbon. It burns up without leaving any ash.

Now, another point in reference to the matter of butter-making. A good lady in our vicinity, in Middlesex Co., once made the remark that her husband need not ever tell her when he changed his cows from one pasture to another, for she could tell by the character of the butter. You cannot make a good article out of poor material. Now, is it not a fact that a great many of our pastures have run down and are not producing that fine quality of feed that we need for the most perfect butter-making? And is it not a question we should consider, whether we cannot improve the character of our pastures?

Then another point. Our Secretary, Mr. Gold, has alluded, and I think very properly, to the matter of the Board of Agriculture testing the comparative value of these different processes of butter-making. If we have these worn-out farms in Connecticut, where farmers are struggling to make a living, they do not want to pay many thousand dollars for second-rate appliances; they want the best, and they want to know what the best is; and is it not one of the things that the Board of Agriculture should do, to test what is the best process, all things considered, for making butter? And I think there is reason for this. We know that in a great many farmers' families the ladies who make butter are severely taxed, and in many instances the profits of the farm have been so small as hardly to warrant the employment of extra help. Ought not the farmers of Connecticut to adopt different methods of butter-making, especially with a view to obtaining the best results with the least labor? I believe this is the case, and I am very strongly of the opinion that the Board of Agriculture would be justified in making careful experiments to determine the best process for making butter.

Mr. GOLD. I arise to reply to one question which was addressed directly to Mr. Hart, but as it has gone so long unanswered, perhaps he has forgotten it, and if he does not approve of my answer, I trust he will correct me. The question was asked, at what time, and in what condition, is the milk perfectly ripe for the churn? I answer, when it is just on the turn to acidity. Not positively sour, but when it has fairly and fully turned towards acidity.

Mr. ———. I have not heard the question of scalding milk at this season of the year, or when the early frosts come, touched upon. Is it better to scald milk or not? My wife, when I come in with the milk from the barn, strains it, and puts it over a kettle of boiling water to scald until it begins to krinkle on the top. When she churns the butter comes readily. She makes a nice article, which we readily sell at a good price at this season of the year.

Mr. **Hart.** Mr. Gold has come very near my experience in regard to the expenses of the cream for churning. Perhaps I will go a little further than he, and say, when it is actually turned to acidity. This matter depends much upon the temperature and the skill of the butter maker, who understands how to regulate that temperature, so that the cream shall not stand too long and become bitter from standing. She will churn it when it is just right, regulating that time by the temperature and other external conditions.

I want to tell a little story about the old-fashioned methods of butter-making, and that obtain now to some extent. I was acquainted with a very worthy couple, the wife bringing up a large family and attending to the butter. It was the invariable custom, after the Good Book was read and the morning sacrifice offered, for the husband to turn to the churn and work the dasher up and down until the butter came, and then he could go to his work. He began to think it over, began to rebel. He thought it was a little hard that every morning, except Sunday, he must do the churning. So one morning, he got up from his knees, took his hat, and off he went to the field. His conscience troubled him all the forenoon; he worked with tremendous energy. Meanwhile, the good mother had churned and worked the butter, and left the buttermilk in the churn. When the good man came in to his dinner, after he had eaten, he saw the churn standing there, and could not stand it any longer. He began to churn. His wife waited until she thought she had taught him a good lesson, and then she said, "I guess you have churned that buttermilk long enough, I will clean the churn." He never again forgot to churn.

Mr. **Perkins.** If our friend Hinman would work all the butter-milk out of his butter and then add an ounce of salt to a pound, I think he would find that it added to the weight. I would like to inquire if he has ever tried working his butter twice, as Mr. White described, before the salt is put in?

Mr. **Hinman.** We have one customer who has his butter always without any salt. My mother always undertakes to get out all the butter-milk after churning. I think she washes her butter in a similar way to that described by Mr. White, and she gets out the buttermilk so satisfactorily that this gentleman, who claims to have pretty good taste, is satisfied with the fresh butter, and I conclude that is doing pretty well.

Mr. PERKINS. Does she work it a second time?

Mr. HINMAN. She works it as thoroughly as possible. That butter is easily distinguished from the other. We have no difficulty in selecting it. It is different in color and texture from salted butter, but there is no perceptible butter-milk or moisture of any kind in the fresh butter. The addition of a little salt and standing changes its color, and liberates an amount of moisture that by actual weight is greater than the salt we put in. It is possible that if we had one of these centrifugal machines and could work every particle of moisture absolutely out, it would grow just as yellow. It might then be possible to add salt without liberating moisture. I have never tried that, because I have never had any such apparatus for experiment.

Mr. PERKINS. Do you believe that the salt changes the color of the butter a particle?

Mr. HINMAN. I know it does. I will hold up my hand on that.

Mr. PERKINS. Does it make it yellow?

Mr. HINMAN. Yes, sir.

Mr. PERKINS. What kind of salt do you use?

Mr. HINMAN. We use just what we happen to buy at the store. That is, nice, clean white salt.

Mr. PERKINS. Do you know whose manufacture it is?

Mr. HINMAN. I don't care whose manufacture it is in regard to coloring the butter yellow. If it has specks in it, it may give any other color besides; but if it is clean, nice salt, it will deepen the yellow color.

Mr. PERKINS. If you add more salt, will it deepen the yellow color?

Mr. HINMAN. I don't know, because we only add as much as we need for our customers. We never use any other coloring matter but salt. We never have needed any, for we do not sell winter butter. But up to the time we dry our cows off in the fall a few turnips or other roots will give color enough to the butter without the addition of anything else.

Mr. PERKINS. I rather doubt the statement made here by some, that it is an advantage in making good butter to have the cream sour. We have tried to get the best method of raising cream. Last May I purchased a Ferguson Bureau Creamer. I know that it is a decided saving of labor, and I know, from what experiments we made, that it has been an advantage in regard to quantity. On the third day of last August, a very warm day, we set equal quantities of milk in open pans and in this Bureau Creamer, the pans holding 64 quarts. At the expiration of eighteen hours the milk in the open pans was sour; we skimmed it, and made two pounds and a half of butter. I ought to add the fact that in the evening there was a tremendous thunder-shower, which undoubtedly soured this open pan milk, which had stood but eighteen hours. The milk in the Bureau Creamer, temperature 60°, when it had stood thirty-six hours, was sweet, and we made three and three-fourths pounds of butter. So it paid us to invest a little in that.

We sent to New York and got a sack of Ashton salt. We found some scales in it from the pans, and it was not so desirable as we could wish—not better than salt we could find in the market here. When that was gone we sent and got a sack of Higgins' salt. We found that salt singularly free from foreign bodies. It is the purest and best salt I ever saw. We salt an ounce to the pound. All our cream is measured, and all our salt is weighed. We are very particular, and yet we come very far short of getting a dollar a pound for our butter.

Mr. DENNY. I have used the Cooley process, and have found it very difficult to produce butter from perfectly sweet cream. From actual experiment I am satisfied that the time to churn is when the cream is slightly acid, and at a temperature of 64° at the commencement. In that way we have got along with churning perhaps twenty or thirty minutes. Before that we churned till we got tired, along towards noon, and stopped.

Mr. CHEEVER. .I will say, in regard to the farmers' wives who "never make any poor butter," that they never remember of making any poor butter. It is a happy faculty we all of us have of forgetting our rainy days, and remembering only the pleasant ones. When a farmer's wife speaks of her butter, she is thinking of June butter. No doubt she does make good butter in June, but she does not like to say much about her July and August butter. She will admit that then her butter does not come very good; it was soft once or twice. We all of us have that trouble.

In regard to the matter of salt, I think many of you must have noticed that butter sometimes, especially in the summer, is streaked. Butter that has been worked but once, butter that has been salted and set away ready for its second working, is striped—"marbled," it is sometimes called—that is, the unsalted portions are intermixed with the salted portions. If it is salted throughout at the first salting, it will be of even color, but if there is an imperfect mixture, there will be white streaks in everybody's butter. Salt does, in a way I cannot explain, color butter unmistakably.

Last week I was invited by Wells, Richardson & Co. to furnish samples of butter for them to exhibit in New York, to show their butter color. It is something a little distasteful to a man, when he is selling his butter at a good price, to show his butter when he has to color it. But I have never hesitated to admit the fact that I color my butter artificially. It is a nuisance, I admit, and to be avoided if you can; I have never been able to do so. In packing my two samples for New York, I wanted to make as good a show of my colored butter as possible, and I salted it two or three times heavier than I would for my customers, and I got it of a very good color in consequence. "Fancy butter," so called, or high-priced butter, must be made fresh to suit the customers who pay for it; they will not take butter that is much salt, and butter that is very lightly salted will be lighter in shade than heavily salted butter. So that the manufacturers of high-priced butter, fancy-brand butter, are rather obliged to color more than they would if they salted heavily for packing. That is a fact.

Speaking of ripening cream, Mr. Gold says he considers cream ready to churn when it is just on the point of acidity. I would add from my experience that that point of acidity can be continued in the same mass of cream, in such weather as we are having now, a week without injury. Equally good butter can be made from cream that is kept sour—not very sour, but just at the point of acidity to which Mr. Gold refers —a whole week, as though churned the first day. And even in summer, with pretty good facilities, cream is actually just as valuable for making the best butter when two, three, or four days old as when it has just turned. I use salt quite heavily in the summer season in cream to keep it in the first condition of acidity as long as possible. By salting and stirring, adding fresh cream, keeping it in a perfectly clean vessel, and stirring it with a perfectly clean utensil, I can make as good butter from cream three days old as one. That is my personal experience.

I want to say one word more about fancy butter. There has not been any such statement made here, but I often hear in public meetings of this kind speakers urge farmers to make better butter. That is all right. But when they say that Mr. A, or Mr. B, or Mr. C, is furnishing Boston, or New York, or Philadelphia, with butter that is bringing a dollar a pound, and that they cannot make enough, and if we would all make butter as good as that we could get a dollar a pound, they are saying what my experience proves is not so. Now I have been getting a good liberal price for my butter, and I want you to understand that the only reason I have not made more butter is because I have made all I could sell at that price. I think that is the case with every manufacturer of a high class of butter in this country. There is no man who is selling butter at a dollar a pound, and making 100 pounds a week, who would not make 200, 300, or 1,000 pounds a week, if he could sell it.

QUESTION. Will the speaker tell what he considers a good price, or the price he has obtained for butter?

Mr. CHEEVER. I will state, for the benefit of those who need a little sympathy, that the price that I have sold my butter at in years past, at retail, has been eighty-five cents. That is the price fixed upon my butter in Boston market. It was sold at that price as long as the market would bear it. But during the years that I have been making it and selling it at that price, some of my friends have been to my house to learn how to make it, and gone to my customers with butter that they thought was as good, offered it for a less price, and got my customers. In the fancy butter trade, as in other things, there is competition. Mr. Macullar of Boston, has begun, within two years, to build up a fancy butter trade in Boston, and has been very successful. He commenced at about forty cents a pound, and that was about the top of the ordinary butter market. He went along until he could get fifty cents a pound, and after a while his dealer said to him, "Your butter is taking first-rate; you can raise the price again if you would like to." He says, "No; I am satisfied; I am making a good thing at that price. Now what I want to do is to increase my sales. Just keep the price down at fifty cents until I make all I want to at that price." That is just the kind of men I am butting against just now, and those of us who have been getting a high price for our butter—sixty, seventy, eighty, or eighty-five cents a pound—cannot stand the pressure of these men who are coming in, who are willing to make 200 pounds a day, if there is any call for it, at fifty cents a pound.

In consequence of this competition in fancy butter I am selling my butter this winter at ten cents less a pound than any year before, and am expecting still lower prices. I don't think the high prices for this class of butter will be within the reach of any great number of people for any length of time.

[Mr. STEWART in the chair.]

Mr. SEDGWICK. I rise simply to say, that when in New York last week I was told by a butter dealer there, that the surplus of these high-priced dairies is sold on the market in New York at only the highest price for good butter.

Mr. Hyde. In addition to what the secretary has said, I think it proper to state that several of the gentlemen who have these new plans for raising cream and making butter have made application to us as a Board to test their various inventions for that purpose, and we have had the proposition under consideration, to see what we could do to further the interests of the farmers of the State. It is entirely in their interest. No plan has been matured, and the subject is one which should be very fully considered before any action is taken in regard to it.

Adjourned to evening.

EVENING SESSION.

The evening session was opened at 7.30 o'clock, Vice-President **Hyde** in the chair.

The chairman read an invitation from the superintendent of the Willimantic Linen Works to visit the extensive factories of that company at such time as might suit the convenience of the Convention.

On motion of Mr. **Hart**, it was

Voted, that the invitation be accepted, and that the Convention adjourn at half-past three o'clock to-morrow afternoon, and visit the establishment at that time.

The Chairman. I am very happy to see so many as we have here this evening, and especially gratified that we are favored with the presence of the ladies. I am sorry we do not have more. I hope on the other evenings of the Convention the ladies will feel at liberty to honor us with their presence here.

Mr. Gold. Excuse me if I suggest that we would like the presence of the ladies in the day time as well as in the evening.

The Chairman. It gives me great pleasure to introduce to you Mr. J. B. **Olcott**, whom I know you will be interested to hear.

HOME SUPPLIES OF FOOD.

BY J. B. OLCOTT.

Mr. Chairman, Ladies and Gentlemen:—The main question respecting Home Supplies of Food is, how to get them? While I was writing this piece my wife said there were but three ways of getting along in regard to our food supply—we must raise it, buy it, or go without. These natural divisions may be subdivided without end. If we grow our food we need to know how to do it by many different methods to make the supply certain. Those who have money to buy with—much or little—yet find it necessary to know what to buy and how to buy to the best advantage. The knowing exactly how to go without this, that, or the other form of supply, which we have, maybe, been accustomed to, or have thought of with longing, or heard of with interest, probably involves more practical, every-day wisdom and a higher philosophy than any part of the main question.

I would follow these divisions and sub-divisions, but I fear a perfect, orderly piece of work would tire me out while you would go to sleep, knowing the end from the beginning, like the pattern of wall-paper. If order is nature's first law, her second is disorder. With the most regular spread of food-supplies there will come the inevitable dishes to wash for somebody, unless we eat with our fingers and drink from the palms of our hands, in the oldest way.

Those who have ready means to procure supplies of food may be likened to the plant that has stood for some time in one place, in good soil and a kindly atmosphere, gaining strength all the while in root, stem, branch, leaf, and blossom-bud. Such a plant may be called fore-handed. This position is the popular one. Everybody would like to be in it, but no one can be without many previous steps being taken by somebody.

Those who have little or nothing to exchange for supplies may be likened to the seed which has yet made no start in life for itself. This should, by rights, be the most interesting stage of existence, because there is, through an ignorance of individual qualities, an element of chance in it, and room for great expectations. It is always from seed or offshoots well planted and nurtured that we are to expect the upright growth for able promise and performance which we all admire.

This generation is precocious, and has small patience for the slow processes of agriculture towards a food supply. It desires to reap doughnuts and hatch a coach and four by steam without the intervention of a plow or an old hen. Because it might be twenty-five years before an idea advanced this evening becomes incarnate in a man or a woman, this farmers' meeting is of no present use, we might say.

My experience has been so much in the seedling stages of existence, where everything beginning life has to secrete its living, I know most about that condition, and consequently shall say most about it, begging the attention and sympathy of my audience for the people who must vegetate and grow towards their supplies of food.

But our attention cannot rest upon the homely supplies I have hinted at, because there are so many temptations elsewhere. There are government supplies of food. Our farm children are being taught by the powerful influence of example, if not by precept, to rely too much upon government. Our school fund will presently become embarrassed by the lapse of its mortgages unless our children are shown the home supplies of food in the soil.

Government patronage is as ruinous for the old-fashioned farmer as it is for the Indian. When the old cow begins to milk herself there is an end of the dairy business.

Betwixt eastern schools and western railways and Indian subsidies, the natural strength of the land is being pushed tremendously.

My friend Meeker lectured upon agriculture once too much. He undertook to teach the savage to plow for himself, and died of "too much talk," with a stake driven through his mouth.

If we farmers destroy the game of *our* hunters too rapidly by education, the disappointed ones—the incorrigible savages of civilized life—will never consent to plow for themselves.

Politicians and office-seekers engendered upon hungry farms can scarcely help the State. Only the good farmer who gives to his land can be the good statesman who gives himself and all that is his to his government.

The hungriest leeches that ever drew the life-blood of a nation, as their home supply of food, are those who indirectly skin the soil.

Violent measures will not help us. We must study the natural processes of death and resurrection by growth. Human governments may sometime become a lesser providence by spells. Let us hope so; but no such fruition can be reached by teaching a people to rely upon its government for a living. Our shrewd old forefathers had a phrase in common use whereby they indicated that any personal neglect was "tempting Providence." We know well enough that human providences are not above temptation. But for government supplies our southern brethren would have had no powder handy to begin the war.

I don't say, mind you, that a farmer who has been successful in keeping the mice out of his own crib might not lend a hand in hunting rats out of the government crib, but he will have to quit raising corn to do it.

We take little thought of the morrow, and live so much from hand to mouth in Connecticut, that it may be that our good secretary meant, when he gave me the subject of Home Supplies to write about, to have me stick to the supplies obtainable in Willimantic, or any other town or city. That food is good, no doubt, and abundant for the time being, but it can only be had directly and honestly in exchange for coin, cash orders, or some other marketable commodity.

No—our secretary of agriculture meant no such thing. There is not a city dealer in the world worthy of the name who would have him teach such a thing for a moment. Our Board of Agriculture, by the powers therein vested, must have intended to use my pen to point whoever would be pointed—away from village stores, away from city markets for his home supplies—to the wilderness, if need be, for a season; to the unorganized stores of food, latent in the soil, and ready to bounce in profusion, by the slow movement of agricultural magic, upon the board of the skillful husbandman.

I have sometimes thought that our young dealers—a few of them—were not exactly posted as to which side of their bread was buttered. Now and then there is a youngster so suffused with western oil that he can't see what railway prices might be but for local competition; but the fathers in trade and commerce know it well enough. Some of them worry, perhaps, more than they need to about the desire young farmers have to bend their backs to city business.

A city editor, pestered with beggars and a rising generation of impecunious poets, may easily say, "Go West, young man." That is a cheap way of getting rid of a questioner. "There is the railroad—your passage-money will be good for that, any how; at the end of it you will find lots of people, scattered around scratching for a living, as you will have to. You can't get back here without learning that lesson. If you should die, the price of your coffin will help somebody, and your shiftless fate will be a warning to the living; but the chances are that you wont die, but will live and get bread and meat for yourself, with possibly a surplus to send east, and perchance have a grateful remembrance for my advice that will induce you to subscribe for my paper. Go ahead, and God bless you, my dear fellow!"

That sort of talk will do very well indeed for a metropolitan editor. He may sound it with a trumpet all over the land. But it will never do for our State Board of Agriculture. This arm of the State must point, as the needle points to the pole, to its own soil. Not silent, like the needle or a guide-board, but full of information as to the minutest details of the way, continually.

Because, you see, a good many of our folks have been west and come back again. Because some of our most prolific families can no longer get trusted at a grocery store. Because coin and store-orders, pensions and pay-envelopes are not to be issued without services rendered. Because the land cries out by the howling tongue of the wilderness for tillage. Because the building of villages and cities in our commonwealth thousands of miles away from their base of supplies is bad policy, bad statesmanship, bad mechanics, and bad farming, tempting our food providence and inviting disaster.

It is so much easier to get rid of our discontented people by sending them out to a mud hovel in Nebraska, with their savings of two, three, or five hundred dollars, there to "buck" against the great capitalists who are driving cattle and sheep and growing corn and wheat by wholesale upon Uncle Sam's domain, that I knew before I began we should have a terrible lug in finding excuses for a contrary course.

"What is the use of spending money trying to teach ignorant people how to raise home supplies among our rocks and sand-hills, when they can be got so much easier and faster at the west?" cries the skeptic. There is truth in this query. Is not our food all fetched from the far west? Do our butchers ever cut anything but "Chicago" beef? Can we bear a morsel of wheat bread without the Minneapolis brand? Is not our soil exhausted? Will it produce white beans—let alone corn, or oats, or potatoes?

O the lack of faith! O the infidelity! O the high treason of the weak spirit that disbelieves in the poorest soil, rightly treated, faithfully loved, worshiped, and worked upon!

If, Mr. Chairman, I had never been that unfaithful one, if I had never been that infidel, if I had never been that traitor, I should not put this matter of the hardness of our hearts towards our own mother earth so strongly. But I know what I am talking about. I know we have but lately quit—if we have quit—driving, by the violence of public sentiment, everybody that we could drive away from the agriculture of our State. Beside driving our young men and women from agriculture, we have tempted, and led, and trained, and educated them off the land, until I venture to say that, of our native stock, the very scarcest man to-day is a first-rate farm teamster, plowman, or plantsman unemployed.

It is old men, or weak and failing men, broken in other employments, or young men with some physical or mental blemish, who have not been sent west, and are still interested in home supplies of food. If this is not so none will be more glad to know it than I; and if it is so none will remember with more courage the charge of old to make our feasts for the wayfarer, the lame, the halt, and the blind, nor the possible use for stones rejected of the builders.

Don't let any one think that I question the propriety of currents westward, or southward, or towards any point of the compass. We want such currents constantly moving, by an easy, natural, peristaltic action, but not by a wasteful, bloody flux.

The Indian had to go, with the wild beasts he preyed upon, wherever he was as wild as they. But he might be left to go slower, to the extent at least of our keeping our plighted national faith with him. Doubtless our Nimrods and Esaus must follow him, and the herder and the nomadic shepherd must follow them, making room, at last, for the furtive plow. But I deny the righteousness of driving this procession like mad by railway and city steam as we have of late, so as to keep the blaze of war burning continually along our frontiers. The Jews have suffered punishment these thousands of years for the way they had of putting whatever they ran against to the sword. If we make a place for ourselves by burning somebody else out, we set an example that may burn us out. The same pressure that pushed the Indians has been crowding the independent farm-life of Connecticut westward, without awaiting its natural process of decay and the growth of something as good in its stead.

We have been "crowding the mourners," don't you forget it! Horace Greeley, the apostle of the western rush which laid Pacific wheat at my door cheaper than I could grow it, said his mother never smiled much after that last, hopeless shutting of her woman's horizon within a new woodland clearing. A younger brother of Horace's might have blown another trumpet in the world, but it would not have suited the great city so well.

A young woman of my own neighborhood, who married and went to Ohio when New Connecticut was new, came back to the scenes of her childhood, and met me on the street. She halted, and I halted. We inquired one another out, and she told me her story: They were five years in a log-house, with the great pastime of taking care of themselves and their children in the woods. She and her husband worked steadily, and were among the first to get into a frame-house. There the children grew up and went off by themselves with their mates, and finally the old pair sold out and moved into the village.

I asked if she had never thought it might have been possible to do all that here in her native town?

"Yes," she answered, "I have often thought so. We could have done as well if we could have fixed our minds as closely upon our home supplies of food and clothing."

Just think, if you please, of young people marrying and running away from Connecticut fashions forty or fifty years ago, in order to fix their thoughts in the solitude of a primeval forest upon home supplies of food, and we shall see the peck of trouble our Board of Agriculture is in with this question to-day.

We have got a plenty of young people, but they dare not marry because each one knows how hard it would be to pay the other's board. We have plenty of woodland, but it is cheaper to bring a stick of timber from Michigan than to hew it from our own hills.

Plant the smartest young couple we know of up in your country woods somewhere, and I'll bet a quart of peanuts, a paper of store yeast-cakes, or a pail of Boston lard, that in twenty-four hours after you have tucked them up in bed with every thing needful you can think of, they will be driving down to the village after something to eat—that is, if they have any ready money.

I want you to understand that a home supply of food in the old farm sense is pretty much extinct. If we find it anywhere we wonder or laugh at it. Our kitchens have become, not a business-place at all, but a sort of a sitting-room. Our butteries are shrunk to cupboards for paper bags, and our cellars have so little in them that we are seriously considering the policy of dispensing with cellars altogether.

From all these considerations, Mr. Chairman, we see the difficulty of approaching this subject. Yet we are expected to learn in one evening what it took the Jews forty years of wilderness life to understand, and the very man appointed to teach—it is a great secret, I assure you—ordered a barrel of beef and a barrel of pork from Providence for his own family use only last week! Now, it is because of the difficulty in Connecticut, as compared with the west, for our young people of native birth to fix their attention upon home supplies of food, that I beg society to notice the matter. Let our politicians, statesmen, and teachers look to it.

There is no probability that a single occurrence happened during the log-cabin life of my Ohio friend to distract her attention from her husband, her children, her cattle, horses, sheep, pigs, poultry, and crops. There was the meeting on Sunday, of course, but the preacher in those days had his farm to pray for as his hearers had. And there was the school, but the teacher boarded around, and knew to a shaving exactly what every child needed to be taught most of to help the busy mother and hard-working father at home. There was a book in every house full of divine common-sense. Sometimes a new settler fetched in a copy of the Connecticut *Watchman*, or *Courant*, but I don't suppose the first hand-bill for a circus or an agricultural horse-trot was stuck among those new settlements for twenty-five years. Out in Nebraska, also, the same remarks hold true. There is, at first, next to nothing there to hinder the quiet grubbing at the main chance of life. Nothing but common local incidents and accidents to prevent the patient and strong from waxing rich and fat upon the land.

How different it is in Connecticut you can't imagine, but I will try and remind you. Supposing William Smith and Nancy Jones have been thinking a good deal of one another, and finally have got to thinking together of other things. Nancy has taught school some, worked in the mills some, made dresses some, and done housework some, thinking of William most of the time. William has worked at farming, joinering, driven team, and tended store a little, thinking all the while of Nancy. Both have saved a little money. The idea is impossible—there are no such people, this is pure romance—but we will go on and suppose that William's maiden aunt, a happy old body, who worked around all her days for her board and clothes, and washed dishes and took care of children, dies and leaves some pieces of a good-for-nothing old farm, long in the family, to William. This disappoints William greatly, who has been thinking of going west; especially when the tax-gatherers of two towns call on him. Nancy wants to see the land. She reads a little of everything, and among all, now and then some old English book about country life. One Sunday in September Will and Nancy go to see the land that had fallen to them—find a Seek-no-further apple-tree, where there had been an old house, with a well, a home lot, and a bit of pasture or plow-land under the lee of the woods.

"Why isn't this far enough west for us?" said Nancy to Will, as she pulled a dead hair from his mustache.

"Perhaps it is, if you say so," said he, and from that on they began to think of building. She wanted a log-house to train vines on, but society would not allow the eastern settler that advantage at the start. The logs must be hewed to a frame and covered with Michigan pine, and a little friendly mortgage.

If William Smith and Nancy Jones were not purely imaginary people, utterly improbable and impossible in Connecticut, I should say their sudden determination to build in the east caused the panic of '73.

"*William and Nancy not going west to settle!*" shrieked the evil spirits of speculation, and every inflated bubble burst!

Now you will partly guess how it was. How everybody thought Will and Nancy were crazy to go off five miles from the city into the woods to live. The parson was afraid the young couple would lose their interest in religion, and cautioned them about growing too worldly. The deacon told Will that he would rather have given him a village lot on a new street he was going to open.

"Ar'n't you dreadful lonesome?" asked all of Nancy's acquaintance, when they happened to see her.

The butcher didn't believe Will could keep any sheep, dogs were so plenty.

Will's planting the stones from an old seedling peach tree, tough as a shrub oak, and nobody knew how many years it had stood on the place, made him distrusted in horticultural circles, and set all the tree agents against him.

The life insurance and lightning-rod men went for him.

First citizens didn't know but *he* might grow strawberries, but they should think village boys would pick them all.

Lawyer Smart thought Will and Nancy—that was at the time of the first baby—were just the ones to take an interest in the new book club.

The school district and town had lots of offices for Will that didn't pay anything.

Everybody he ever worked for wanted to hire him again.

The village doctor was afraid Will's barn-yard—he was always carting in or carting out something from it—would breed malaria.

One of the village dowagers—a patron of Nancy's—drove up to see the new settlement, and spying Will's orderly tool-shed—he was a master hand for the best implements—told Nancy, "*There'll* be something to sell in case William should be taken away."

Nancy's Cousin John, boss of a room in a cotton mill—gossip said there had been a mitten between them—kept watch of the thing, and happening along when Will was unloading his mower, wanted to know if he hadn't "got all the machinery in yet?"

Will laughed at all this; on the whole he rather liked it—recognizing the signs of success and admiration, but he knew well enough there would have been no such bother out in Nebraska. Nancy sang about her house-work like a bird. Till the children got big enough to help—yes, and after that, when society began to have its equivocal way with them—she often lent a hand in the field.

They had plenty of friends from the start—old-fashioned farming people; scholars with more brains than money; mechanics and artists who found a life pleasure in labor and thorough work; and business men who loved to see all sorts of business going on, east and west, gave the strange venture the kindliest recognition. They kept making friends, often excusing themselves from returning visits because they lived so far back—"out in Nebraska," they said sometimes, in a joking way.

Will could work just as many hours as he had a mind to, and he had a great tact for having things ready for present need that must have been done a good while beforehand.

He was quick with tools, and made chips of an evening that would keep Nancy's pot boiling for a week. Shrewd old dealers liked his close way of bargaining and paying cash for things that only they and he knew were useful—remembering the time when they made their first hundred dollars in business.

But why romance in this way? Let us quit it, and try a little real life for a change, even if it does not run as smoothly.

All this beating about the bush, however, will help us fix our minds upon the home supply of food if we are only hungry enough.

Take notice, if you please, that the difficulties in the way of beginning a new family life in the country are not insurmountable. Sometimes, in thinking of them, my thoughts take on the language of the old preachers. The trouble is in our own hearts. We must go apart from the world a space, and renew our hearts and refresh our courage by meditation and prayer, with fasting, probably, if we would avoid store bills. Manufacturers have been very nimble in picking up the old family industries, but if once people of taste and intellect become heartily in love with rural life I do not despair of seeing tip-top fashions originating upon country farms. If we will but open our eyes to realities, we shall see that going on already. We might sew, and spin or knit and weave to ten times the cash advantage on the farm that our grandmothers could if we only thought so. The greatest trouble is that we have been taught some other way of getting our bread until we have forgotten the old way. My mother would have laughed at the idea of lamb's-tail wool and cotton selling in the form of gloves and mittens for $2 a pound. So long as she could buy a knitting-machine for twenty-five or thirty dollars, she would know very well how to pay for her tea, sugar, and spices in any city or village. And no manufacturer could alter his patterns so quickly as she could, for with the change of a thread or two of color, purchasable now in any of the shops, and mingled deftly by the cunning handiwork latent in all women kind, she might make every piece of her work of a novel pattern.

Farm ingenuity is not dead but sleeping. The great work of putting the State on a footing level with the nations as regards her industrial trades has expended, but by no means exhausted, the resources of the land. Boys, however, who don't know a clout from a shingle-nail, and can't saw fire-wood square across the grain, are too commonly produced in the country for the best home supply of food there.

New England manufactures began in farm kitchens, unless we admit the aboriginal artisans in clay, wood, stone, and leather to have gone before, and I expect the policy of letting people work at home will be found a saving policy still. Prison manufacturing has become an embarrassing feature in our social polity, and statesmen perceive that a weakened family relation may leave too many applicants, in one form or another, for a public provision. The time was when skilled artisans dwelt on back-country farms. As our rural districts grow neat, orderly, and inviting to the mechanic eye, skilled workers of the more independent sort will make their abode in them.

By cultivating kindly relations with clever workmen, and making good gardening common along all country roads, we shall bring farm mechanics to gather their home supplies of food from every hill-top.

Since our villages, towns, and cities are stronger and more populous, individuals and families are found worthy of being selected, and planted out upon broader spaces for seed.

The strong villager does not require the money paid his employees to return by a sort of roulette arrangement to his own pocket now, and the great city—our capitol city—is greater to-day because she refuses to absorb all business, and allows farmers and mechanics to minister to her home supplies by their labors at home.

Large landholders, by the way, miss their figure greatly in their general method of trying to vary farm diet with the supplies a commercial center might bring to their doors. They are too stingy of their land. They expect a manufacturing village to grow up around them while they keep possession of the soil. Shrewd mechanics never enter any such trap. Another thing: Mechanics were never known to do much where the soil is very productive. Western and southern speculators are finding that out. We can't keep the workman's attention in a mill while the landscape outside flows with milk and honey. Winter scholars do famously in this climate, and it is where nature runs rusty that art begins. Where agriculture is poorly repaid, there manufactures take our eye and men work busiest to bring in stores of foreign food. If the extensive farmer wants to plant a village, let him straightway part with his land at the market price to any industrious people who will take it. When population crowds and food gets scarce, mills for winter employment and food will spring up spontaneously, like mushrooms. Connecticut manufacturing villages, with scarcely an exception, develop where the land is so poor that the owners do not care to keep it.

My wife and I became inspired with the idea that we could live in one of our New England wildernesses while eating a meal of baked potatoes and milk. The milk was new, from our own heifer, and the potatoes had been washed very clean and baked brown with the skins on. Hungry people find out, in snug times, that the chief virtue of a potato lies next the skin, as the choicer part of the wheat kernel does. It won't do to burn the skin in baking, but rather to heat it fervently, so as to induce a most palatable sweetness beneath the crisp outer cuticle, akin probably to the chemical change by heat in the crust of bread skillfully baked.

After eating one plate of that it touched the spot, and was producing that agreeable fullness under the waistband which belongs to good digestion in the midst of a meal, when I exclaimed across the little table—

"By George! Em! we can have 'tatoes and milk up in the woods, any way!"

"That's so," said she, echoing the sentiment as heartily as a mouthful of the blessed victuals would let her.

Now, in all we have to say about gathering home supplies here, we must never deny that a man or woman may play a lone hand at the game, but a pair is better, very much better, if they have ever come to any such agreeable starting point, and three or several of a kind is better yet. We had been married then, you must know, twelve or fifteen years, but in all that while I had never felt quite so much married as after that family sacrament of baked potatoes and milk.

You see we had already begun to dig in the woods just across the brook from my father's house. We had a garden planted there, on what he called the poorest land in the world, and a well, and perhaps a cellar dug, but I have not told any body what a great dread, and how many forebodings of poverty I suffered, while going that short distance into a Connecticut huckleberry woods to live. All surrounded by near and dear friends as we were, residing in old established and time-honored places, the naked and desert condition of that promised land was fearful. It would have been far easier, quite gay and festive by comparison, to jump on the cars and drive away two thousand miles among the indifferent faces of total strangers, more friendly, and more akin, and more sympathetic, because they would be recent settlers like ourselves, and fighting the same battle for home supplies of food that we had to.

The tyranny of successful manufacture and successful trade —the well-meant tyranny of a different example—is a great bar to the production of home supplies of food in New England.

"Home supplies of food"—*does* the Board of Agriculture, after all, really mean food from *these* farms close at hand, or is the phrase to be understood in a broad, national sense, as we speak of home manufactures? The latter term once applied to the chests of linen and stacks of blankets and cloth spun and woven in the populous farm homes of Connecticut. Then the doctrine of protection for home industry did not mean a government bounty upon foreign establishments located here to escape taxation—money, machines, people, raw material, and finished goods, all foreign, and all opposed to the original theory and practice of family and farm independence.

Whoso taketh the sword shall perish by the sword. Whoever drives his neighbor to the wall by the strong arm of government, may himself be sent to the wall by the same power.

I tell my farming friends to beware of government bounty. Touch it lightly. If capital takes a subsidy labor will soon want a bonus, and all hands will wish to vote themselves back or future pay.

It may be thought by some that in connection with this home food business I harp a good deal on outside matters. Well, I found in writing up this subject that I had to make room for the swarm of young ones coming after us. In getting a supply of food into my own house, upon my own table, and into the stomachs of my family, I found the whole neighborhood had to be moved a little before they would give their consent. In digging my cellar I had to break up one of the oldest burrows of woodchucks, rabbits, and foxes there was along our whole country-side. We interfered with popular rights in building there. A woman who lived half a mile away, long after we had got settled, declared, with considerable feeling, that we had "spoiled all the place to pick huckleberries there was."

To raise our own food in Connecticut we must touch more outside matters than we shall think of till we try. The careful plants-man discovers, in so simple a thing as putting in a hill of corn with a hoe, that stones and roots lie just beneath the surface. In planting mechanics, manufactures, and commerce upon the broad base of capital, we have touched a thousand matters outside the range of our fathers' ideas. That we have changed the whole structure of society and altered our finance, commerce, and religion, goes of itself without saying.

A corresponding change in the old style, extensive farmer is inevitable. He must adapt himself to some things, and some things will have to adapt themselves to him, because he is a natural and necessary being, sure to be of use wherever there is room for him.

Our fathers in manufacturing have been very busy men, working for goodness, as they saw it, in the distance, with all their mind, soul, and strength. But they have found time to grieve, while they wrought, at the decay of agriculture about them.

"Why is it," said a great machinist to me—himself bred on a thoughtful Connecticut farm—"that these young farmers are driving down to our mills for work?"

I couldn't tell him then; they did not know themselves, but I know now. It was because they were starved out intellectually. No one fed their minds. They felt themselves of no use in the world, and there were no mental or moral physicians to explain the new movements of society so that they might work on a farm with a reasonable hope. These young men felt the need of going to some industrial school, where they might learn somewhat of the outside matters intimately connected with their home supply of food.

You will not understand me to say that I would not have the Connecticut farmer buy any food. On the contrary I want him to buy whatever is to his profit; but I want him to be able to pay for what he buys. We must buy and exchange commodities to live. No farm can be big enough to supply all of its manifold, various, and constantly changing needs. Our cosmopolitan origin obliges us to be an omniverous and great commercial people, ransacking the globe to feed ourselves. Just so fast as our people are mixed by steam, the various foods they have been accustomed to must be mingled by steam.

All I ask is that now, for the next step in the progress of our commonwealth, we exercise a spirit of forbearance, and do not make our would-be rural people, with but little money to pay store bills, ashamed of the inevitable and necessary privations of farm beginnings. Let the raw recruit in Connecticut without capital have, as nearly as may be, the same chance to begin small that he would have in Nebraska. Give him time to develop. Let him eat his home-grown provisions, according to his skill at producing them, in peace. Don't try to educate his children away from him. Let them bide their time—like seed of pine, oak, and chestnut—and take root in the soil. Don't meddle with the beginner, thinking to do him any good. Don't ask him to come before this Board of Agriculture and tell how he does things, unless you are sure he has the leisure and can afford it. Let him work and work out his own salvation. If he gets into trouble and comes to us that is another thing. Otherwise let him be, let him vegetate, as he might out in Nebraska.

When I began farming for myself a friend asked, cheerfully, if I meant to run a market-wagon into the village? I said 'twould be all we could do the first year to get what garden sauce we wanted for ourselves. Fourteen loads of rather weak and leafy stable manure didn't go far in the corner of our five-acre garden-lot, and our minds were set like flint upon supplying our own wants first, just the same as if we were out in Nebraska. On an isolated farm, as on ship-board, you must look out for No. 1.

We began with a wheel-barrow, then came two ox-carts—carts were not as plenty as oxen, within our reach—then my father let us have a fifty-dollar horse to keep, and we got a broad-track lumber-wagon over here in Ashford, with a spring seat broad enough to hold our whole family of five. After a year or two we got a tough old express-wagon, then an old buggy. The one-horse mower and rake dropped down on us before the lumber-wagon. Bye and bye a two-horse wagon and harness, at second-hand, came along, stuck in the bushes like Abraham's ram, just in the time of our need, having another old horse. Then the steers grew up to a small new cart. One of the old carts was rigged to dump after horses. A better horse in place of the old one demanded a horse-cart for light artillery, and the steers grew heavy enough to handle the other ox-cart with new broad-tired wheels. This is the old slow way of growth in farm beginnings. It was seven or eight years before we could make any pretence of a daily market-wagon, and that only for a few weeks at a time. Since our villages were supplied with food from the west principally, they didn't care so very much whether we fetched in anything or not. But all this while our farm-manure piles were increasing, our garden was growing richer, and our home supplies of food were becoming more regular and certain.

As it happened we had made a close study of strawberry-growing, for love of the fruit, twenty years before we ever thought of selling any; so as soon as ever we could we planted them for market—swapped them, in fact, for home supplies of food, and many other things that we could not get so easily in any other way. If we should ever wish to emblazon a panel of our latest ox-cart with a coat of arms, I guess we should select the strawberry *couchant*, on a ground of pine leaves, as the principal emblem. Another family might do as well, perhaps, with lettuce, cucumbers, green corn, horseradish, celery, cabbage, turnips, currants, cauliflower, or asparagus, and many another thing, if they knew as much about it and worked as hard at it as we did at our specialty. These gardening tricks can be played upon the public to a great deal better advantage in Connecticut than they can in Nebraska.

I dislike to do it, but it would scarcely be fair to pass another item in this inventory of the springs of our supply of food upon a sterile farm. Years before, the knack of letter-writing to friends—distant friends—came to my hand, and in a season of desperate leisure, from ill health—a sort of turn of life which every man has, or ought to have—there came a little opportunity to print letters for pay. I know nothing about it—I have really tried to keep the swindle as private as possible, and to give value for value, but it is certain that my weekly crops of Yankee notions have not drained our garden of phosphates as much as annual wheat crops drain the soil of Nebraska. The little rivulet of money from the city turned steadily our way, helped mightily towards our home supply of food. We made friends by writing, too, and we spent a good share of our pay in wheat bran phosphates from the far west very thankfully. Writing for print is a mechanical trade quite as much as it is an art. The pen is a tool, and fortunate is the mechanic's apprentice who learns the use of an implement that he may own and have by him, when accident, necessity, or choice brings him to seek supplies of food upon a farm any where in the world.

A supply of food for thought is a first-class necessity on the farm, where close contact with the vitality of mother earth makes mental digestion strong and lusty. I despise a book or newspaper worm. Let us match virile thought with a deed as virile, or a mental sterility worse than any possible barrenness of the soil shall become a chronic habit. The vice of reading, speaking, or writing lies in considering what is only well said as well done. A good job will be thought to completion beforehand, but the job is no more to the thought than a perfect bullet is to the empty space of the mould. I want the farmer to be a reading man, and able to say his say on paper. Let him be familiar with ancient and modern thought. Let him know how it is that the civilizations of history—like fattened swine swimming—cut their own throats by denying the debt of all animate nature to the soil. Let him understand the still small voices of the earth, and be able to speak and write for the ground as one having authority. I want him to know the meat, skin, and bones of a book as well as he knows bran, *canaille*, and flour. He must do that in these times, or take his old place in older countries, as the nation grows old, of agricultural peasant.

A delightful American author heaves out the idea that a talent for letters is hereditary, and that there is a natural "brahmin" class in literature. This idea is as true of agriculture as it is of the other art, but it does not accord with my notion of a liberal education, nor with my knowledge of facts to claim a birthright as the entrance to practise in either. I claim the natural right—latent, dormant though it be in places—of cultivating a home supply of food for the soul on every farm. If any farmer chooses to neglect that crop and beg or buy his supplies, or go without them, that is his business. I can only remind him of his rights.

I am disposed to emphasize this matter, because one of our most popular governors stopped me in the street last summer, in the midst of the strawberry harvest, to marvel that any fellow who could think and write as well as I could should choose to stay on a farm and do it. You will pardon the egotism for the sake of the curious view of public opinion.

Reading and writing require a man to see and think squarely and connectedly. So does farming, gardening, and mechanics. To wring rough words and wry sentences into a smooth paragraph is all the same as packing rough stone or combining crooked rails in a strong and handsome fence, provided a fellow has the same practise and love for the necessary work of each. The farmer may read, write, and print in this 19th century republic, and still be old-fashioned enough not to excite envy, since the world of manufactures, commerce, and trade is making use of so much quicker connections by telegraph and telephone.

Students and scholars in all ages have been fond of the earth. Sometimes they were fain to burrow in it to save their lives. In latter days our colleges and schools, as well as our manufactories and institutions of reform, are very apt to want a farm at their backs. True scholars and farmers naturally come together in all ages, and a fair knowledge of letters need not imply that a farmer's ancestors flung books and pamphlets at one another's heads a hundred years ago, like so many bull chimpanzees.

Farmers must be able to write closely in order to read closely and get the pith and marrow out of books. They need to understand what they read well enough not to sign a promissory note without knowing it. Society fails when ignorant rich men bait rogues.

The life of the isolated farm would not be isolated at all if the farmer should make the good company of all ages his cotemporaries by surrounding himself with good books.

If an ignorant rich man founds a library after death, very rarely does he leave books where such back country boys as he once was can get them.

There are schools and libraries, all made from the concentrated energies of the soil, but the trouble with farming is that our bright boys have to go away to enjoy them, and so get trained and educated to waste the farm.

Some writer has said that our rural schools "are fifty years behind those of the city and village" in furnishing home supplies of food for the brain.

Now about victuals. We have been all this time working through the crust of our pie. I call it a great day for the old commonwealth when its Board of Agriculture discusses popular food. We are breaking the ice, I believe, for the State Board of Health and the State Board of Education. State temperance hangs by the gills waiting a better common sense as to human nutrition. They do say our folks are moving west now, Mr. Chairman, to get rid of fever and ague and malaria.

Food being the grand source of farm power, we must look to it. Last May, when dairy produce was so low, we worked all the milk we conveniently could into a bull calf and then swapped the calf for half a barrel of corned beef. It was perfectly astonishing, when that beef barrel exploded, to see the work it did. Nitro-glycerine is undoubtedly powerful in its way, but beef is better as a general farm motor. The butcher made the swap, did all the weighing and ciphering to his heart's content, and thought, doubtless, he was making a good thing of it, but he could have no conception of our side of the trade. A pound of beef well managed will move thirty or forty loads of dung, earth, or gravel, and put it just where you want it, and there are some days so busy on a farm that running to the village after a bit of meat to put in the pot might damage a fellow twenty-five dollars.

It is hard enough to scrape up a home supply of food on the farm, but the trouble of exchanging a surplus of that for money, and that again for other useful things, multiplies the original labor by three. This is where the righteous middleman comes in. Much scowl o' brow has been spent in getting rid of the middleman. He may always be changed, improved, and educated, without a doubt, but never abolished. Every man, in his place, is a medium—a saviour of somebody or something—by the grace of goodness! And the fellow who would do away with mediation would abolish himself!

The first grain crop we made for ourselves was buckwheat. That is very properly threshed in the field, and suits a farmer who has little or no barn room. It can be stored to keep for years in an upper chamber, furnishing power to build a barn and granary. Every grist-mill does not grind buckwheat every day in the week, and western buckwheat flour is sometimes adulterated with the siftings ground out of wheat bran. Buckwheat cakes—slap-jacks—are handy for breakfast in cold weather, with meat or milk, not being of themselves sufficiently nitrogenous for a complete food. Syrup and butter do not strengthen buckwheat in the right direction.

An excellent minute pudding can be made of buckwheat flour. Scald half a kettle of new milk, salted; sift the flour in through the fingers, stirring rapidly till the pudding is smooth and stiff enough to be taken out with the pudding-stick into cups, a bowl, a deep dish, or a fancy mold. With a sauce of fresh, thin cream, sweetened with maple syrup, this pudding may be all home-made, quickly prepared, tasty, very filling at the price, easily digested, and quite satisfactory for out-of-doors people in our climate. Whatever is left may be sliced and fried.

The prints are full of writers' objections to the frying-pan, but very few of our people sit and write too much. Where every thing is fried so that the house and the clothes of all the inmates smell of burned grease all the while, the home supply of food is a little too obvious.

Green corn must be a Yankee food for out-of-doors people in this climate, as it was an aboriginal food. Planted of some sweet and tender kind a half dozen times in the season, it serves any meal during latter summer for all the inhabitants of the farm. Keen farmers have a way of drying a lot of it, so as to have it better in winter than most city markets do in summer. Every good sweet-corn farmer ought to try to fill that gap in the market to his own profit and the good repute of his section of country. Green sweet corn is corn in the milk, and bears transportation and long keeping no better than milk does. A good kind of sweet corn plucked in exactly the right stage of the translucent kernel, and boiled not over twenty minutes, is too good already to salt or butter. I'd as soon think of buttering a Persian muskmelon.

The Indian taste for corn was good. The white corn of the Tuscarora tribe makes very soft meal, which cooks quickly, and can be digested by persons who cannot eat gritty, flint corn meal. It is the nearest to a bread grain of any maize I ever raised, makes porridge that is good hot or cold, and the journey-cakes and muffins made of it are soft and tender. Parched, ground in a hand-mill, and moistened with rich milk or cream, it is good enough for the poor, and the fresh parched meal is delicious dry.

I could not in a week of evenings shake a stick at all the items of good living that a farming family may have after awhile, if they work for them with all their might.

We don't put labor enough on the farm to make victuals plenty. It happened in our neighborhood that a couple of mills burned down and threw a young man out of a job who just suited our business. We paid him $2 a day by the season, and he was cheap help for three years. He helped us do a good many things which ought to have been done a hundred years ago, and a few things that may show a hundred years hence, while we made our daily bread. The fact is, on a farm, the more one works for it the plentier food grows, and the more victuals there is the more one is able to work. After making a place for yourself on the land, pitch in and make a place for another and another and still another hand. The more the merrier, so long as all turn a cheerful face to the next difficulty. That is the way cities are built. Where the parents are determined to stick, the children catch the home-building spirit. The boys go away, if they do go, to learn a new industry, and bring that home as Russian Peter did. They bring home industrious wives, and the girls fetch home industrious husbands wherever food promises to be plenty, and people are taught to labor to make the good promises come true.

Salt beef and pork ought always to be plenty in the farm cellar, to season and relish with fresh provisions. Starting in farm life with only a calf or two, the beef-barrel is not likely to be filled, at first, with home-grown meat. The fashion of giving up salt meats is a good fashion for trade, but bodes ill for farm independence.

Good dried beef is a great convenience, and relishes in midsummer, at times, as nothing else will.

Pork—pasture-grown—will have its place on the farm till the world's great labors are pretty much done. The generation passing off the stage probably got a little too much of it. In a warm winter it happens sometimes on the farm that spare-ribs, souse, and sausage are too plenty for health and comfort. Probably the old farm practice of killing hogs just before he was expected killed the school-master that boarded around also, and broke up his wonderfully effective and useful home-missionary work. The pig would be a better deposit of the poor man's savings if the windward corner of the sty were more frequently littered with earth. The builders of the old Jerusalem would not have swine rooting around their corner stones, and I sometimes think the coming man will not have a hearty relish for pork three times daily, unless the coming man turns out to be the cheapest kind of a Chinaman. The old hog-pasture style of growing pork should be patronized more. A village lot—centrally located between four or five pig-pens—might be enjoyed by swine in common. The timbers of the farm kitchen may often hang with flitches of bacon to great advantage. Many a poor neighbor has to walk far beyond a strong farm-house to purchase his supplies of food.

Of poultry there can be no end in the farm-yard. Very few people nowadays have even tasted all the varieties of domestic fowls. Old hens lay their layings out and ripen properly for the pot or oven, all summer long. An old fowl should boil an hour before baking. Good livers in the country keep an airy feeding-coop of fowls coming on in rotation for the larder. Eggs, fresh from the mint, are the current small change of the farm housewife. Turkeys that range widely and come home nights to roost are most profitable. It is a wonder that our far-western brethren, with their cheap corn to finish with, do not keep millions of turkeys to consume their grasshoppers.

Mutton is my favorite flesh meat. I am as fond of it as a village dog. We need not have that which must be parboiled to extract the taste of sheep, either. Southdowns in good hands have no trace of that, and I believe we may bring in several other kinds of sheep that have not. The absence of sheep is the present disgrace of Connecticut agriculture, and their coming to stay is the crucial test of good farming. Good mutton—wether mutton—not too fat, is the next convenient package of fresh provision going, above the turkey or goose in size, and more of an everyday article than either. No end of farm industry hangs by the long wool of the mutton sheep. Let bright farm-boys say they will, and by the help of good mutton Connecticut may regain possession of her meat markets. But the successful shepherd must have a fine taste himself and grow mutton for its flavor.

Not only must the farmer strive to be able to grow these meats, but he must know how to dress them nicely for family use. He must know these things for self-defence, although he may not always care to practice them. Often and often some farmer is obliged to dress his surplus stock to turn it into cash. Trade sometimes takes such a turn that the strong farmer—bold in his own right—is called upon to run a meat wagon to furnish home supplies of food for his own neighborhood.

With meats we must have vegetables. If a young couple take each other by the hand and go into our Connecticut wilderness to live, it is no matter how cheap potatoes and turnips are in the village or city, they are worth twice or three times as much in their own garden. Home-grown vegetables do taste and relish better, even if the quality is not any better.

When the trades are so profitable that a mechanic can afford to neglect his garden I am always sorry, because I know that he is bringing his children up in ignorance of things all children ought to know, and that hard times for the trades are ripening.

Years before we built our barn-house we made a garden and planted asparagus, pie-plant, and strawberries, because I knew these things were going to be needed there, and would be very hard to get. We can begin a garden while we are thinking about building a house. Building is such a great strain on our resources that many important garden matters are neglected and forgotten for wretched years. You may time a strawberry bed so as to pick a bushel for the friends who come to your raising.

Americans do not eat cabbage enough. Cauliflower is more delicate, and by some supposed to be finer, but a sweet and tender head of cabbage cooked by itself, with sticks across the pot to keep it out of the water, and dressed with cream or rich milk after being slashed small in the dish, is to my taste better and more nourishing. Cabbage gives off a mortal smell while cooking, but that can be sent up chimney if we have an open fireplace to boil it in. Many people who have given up cabbage, as they have had it swimming in grease and salt water, find it excellent for their complaints, if minced fine —no matter how fine, nor how crisp and fresh the cabbage is— and dressed with a little cider-vinegar and sugar. Of good rye bread and butter with that salad one may make a full meal.

I am not giving you the recipes for apple-fritters, angel-cakes, etc., so common in the domestic columns of our newspapers, because the most of those fancy dishes have not sufficient life in them. We need not stay very near the ground for our food if we don't care to have it fresh and racy of the soil. And I am the more disposed to urge our rural people to study the best natural flavors of their food for themselves, because these fresh flavors in perfection are their own various and inimitable trade-marks, sure not to be copied or counterfeited, and always certain in the long run to command a price in market. When we have learned to produce a choice supply of any article for ourselves, it is but an easy step to make a surplus for sale. The way to make a market for our home supplies of food is to show that no distant person can produce them as perfectly as we can.

We must study our market and learn what the popular taste is by sampling the food there, remembering, like the wary manufacturer, that the thing we produce for sale next season must accord with the styles of next season.

To wean ourselves from the stamps, paper bags, and trade-marks of others, we may have trade-marks, paper bags, and samples of our own. The best trade-mark is a full measure or weight of fine goods in the best order.

The parsnip is the longest keeper among roots. It may become withered and yet remain excellent, and will hold in fair condition till August. We prefer letting them rest where they grow, with salsify and artichokes, for early spring digging.

Forced pie-plant and asparagus can be had all winter long from a sunny corner of the cellar, but the New England philosopher will take the rigors of winter kindly on the farm, and be willing to let spring come to him welcome with her arms full of blessings.

We dug sound sweet potatoes in our garden after Thanksgiving. A family supply of these may be grown without any fear of the potato beetle. The boys spread a bushel of peanuts on the garret floor to dry this year.

Squashes are among our solid winter enjoyments. The hard-shell varieties may be opened and cleaned before baking and serving on the half-shell. No squash is improved by mashing, and the same remark is true of the turnip. It is a good cook that knows when to let things alone. Stewed pumpkin, of the sweeter varieties, served perfectly plain, has but a simple taste, but the water of it is an excellent solvent for bodily impurities.

Onions are not so much required to be eaten by mutual agreement and association now as they used to be. The old English way, of frying them brown to smother a bit of juicy broiled steak with, should not be forgotten.

The farmer's wife with whom I am most intimate sells what little butter she has to spare, at an extortionate price, and sends me to buy a home supply of beef-suet, at three cents per pound, to shorten her chicken pie-crust with. She has a tasty way of covering a pot of stewed beans with bits of beef-suet before baking. If any body wants oleomargarine, they will find it cheap and excellent in that form.

There is one thing I came near omitting. It is too often omitted, since the old-style farm house wife is so nearly extinct. That is tripe. I heard Cassius M. Clay of Kentucky say, years ago, in one of the New Haven churches, that the feet of a bullock, properly prepared, were the best part of him, and he said it with so much unction and grace that I believe it to this day. Now, to my notion, tripe—the paunch of a beef properly cleaned and prepared—is the second best thing about him. But our tripe has lost its savor. Thin, lean, leathery stuff, pickled in spurious vinegar, is a fraud. I wish I could tell how to clean tripe. I have cooked it, and when a boy helped my mother clean it, white as paper, but I haven't the recipe at my tongue's end. 'Tis a pity to lose the art and science of it. If I had the means I would certainly endow a seat in some college for this learning and perhaps a few more necessaries of life. Don't think the idea absurd, now that a Board of Agriculture takes up home victuals for its chief business. I keep hoping that some unsophisticated old countryman will come over and help us in the matter of tripe. A Scotchman sent me one of his country newspapers, which showed, by an advertisement, how much better the tripe business is managed abroad. One who wished to retire from the trade advertised the good will of it for sale. He claimed to dispose of "Seven Bellies a Week." I don't believe they were pickled, and no man, with such a snug and well-established business, yielding him a respectable livelihood, and laying hold upon the breakfast and supper tables of a responsible and salable route of customers, could be so destitute of the bowels of compassion—so to speak—as to scrape off every shred of the delicious fat from his tripe. Just think of the absurdity of broiling a pickle! And if tripe is always to be made acrid with the vile imitations of cider-vinegar, how are we going to serve it—shade of Mother Hubbard!—in a crisp egg batter?

Tripe (like sausage) should be prepared at or near home, by some person whom we know and have confidence in. By some member of our church, or society, or club, if possible, who will humor us in the matter of thickness, or "honeycomb," or "wrinkles."

Rye is a great comfort on a farm. It is so hardy and plenty and common that I am not disposed to yield its first place of particular usefulness, in humble homes, to any other grain. The strongest, sweetest, and gentlest farm-laborer I ever knew—an Irishman, by the way—marched to his work at four in the morning, with a bare loaf of rye bread for his breakfast and dinner, and was content. The Connecticut statesman will touch his hat to a head of rye whenever he sees it. The opinion of the old lady who couldn't bear rye in bread, but as whiskey "could manage to worry down a little," may be taken for what it is worth.

Wheat and oats are being overrated for commercial reasons. Barley will be preferred by many to the latter. Either will afford a better meal than any aged preparation of commerce can be, where skillful local growers and millers put their heads together to make them.

Wheat has been manipulated for market at a fearful rate. Those who have accustomed themselves to merchantable commodities find home produce of their own growing very crude and unsatisfactory at first. If the consequences were not so serious, the commercial attempt, by one of our "scientific" experts, to replace the missing phosphates of superfine flour by a phosphatic, self-raising, chemical preparation would be laughable.

We had a curious experience with wheat ourselves. A friend had given us a little winter wheat in a vial, that grew accidentally in his garden, a part of the produce of one seed, which made about fifty stalks and perfect heads. We sowed it carelessly in our garden, two seasons, where it would be sure to have a hard time. It behaved so well that we concluded to drill it in September across the strongest soil we had, where we intended to plant strawberries the next spring. The drills were five and one-half feet apart, and we used less than one quart of seed on a third of an acre. The little patch grew famously; on the moist end the rows lapped together with the weight of grain, covering the new strawberry rows. Growing wheat was such a novelty in our neighborhood then that a good share of the handsome bearded heads went for winter bouquets, but we harvested and bagged over eight bushels from the patch. That gave us enough to try the flouring quality. It proved unsuitable for pastry, and we got to using the meal for mixing with trade pastry flour, so as to make the latter satisfy farm hunger. That is an old trick of the bakers, by the way, with dark, glutinous wheat.

That same winter we got to experimenting with the cereal preparations of an ingenious and enterprising New York establishment, that was engaged in refining and dividing all the grains by wholesale and retail. Their wheat gluten, boiled, cooled in cup moulds, and served like *blanc mange*, cold, with cream and sugar, seemed to hit our complaints exactly, and we thought for one while that, with all our garden, we should have to pay tribute for ever to this New York manufactory. But the idea occurred to us of trying the finely ground meal of our own wheat in precisely the same way we were using the prepared gluten. We found it practically the same thing, but a full notch or two better, because it was fresher and had more of the delicate volatile oils and essences of the grain that no chemist's retort or maw of cattle can account for. Maccaroni is dead gluten, resembling that of fresh wheat as the missives of the dead-letter office resemble those which come to hand to-day.

Don't forget fish, among your home supplies. I admire the catholic practice of our churches in putting the use of fish in the form of a regular pious custom. In places where we are not manufacturing so strongly as to soil our streams too much, fish may be a profitable branch of domestic growth and culture. Perhaps the European carp is going to help us. Small boys, if encouraged to have their fish poles around in the summer season, will sometimes hook out quite a string of fish. Boys and girls should be early trained to add their share to our home supplies of food.

The enterprising fish peddler is a very useful member of society. He may return to the farm a portion of the valuable substance that has been washed into the sea.

Quite accidentally we got a new wrinkle as regards sword-fish. The first we ever tasted was part of an aged but sound salmon-colored lot, repacked in small tubs for family use by a smart wholesale dealer. We were very fond of it, and I got a direct order to "buy a hundred pounds," it was so good. On making the second trade I found that fresh, new sword-fish is as white as tripe, and bought that, paying considerably more, supposing it would be nicer. But we never liked it, although we tried hard to, till it began to grow salmon-colored with age. As the poet remarks, "There is sweetness in decay." Salt sword-fish should be thoroughly freshened and plentifully dressed with rich milk or cream, after being well boiled—some say in skimmed milk—and partly broken in pieces.

We have no time to inventory even all the available home resources of food. If we are not in want, then the subject may lack interest, and if we are hungry, the invention to supply the necessity on a farm is very likely to be muckle enough for the occasion.

Since we have to grow, buy, or go without food at home, the growth, to be had in time, must be spoken for in time. The great trouble with our would-be farming people who fail, is—they didn't have faith, or prophetic gift, or power, to bespeak the ships a good while ago that they would like to have coming in to-day.

The orchard—apples, pears, peaches, and plums, can't come, with the best of treatment, in a season. By the way, does the State coat of arms really show three grape-vines, or are they being developed on the circulars of our State Board into three old apple trees? Our land-owners will be wishing, presently, that they had had more faith in the earth. If the small capitalists of Europe are coming to settle among us, they will be looking for improved property. Orchards well planted with all suitable kinds of fruit will be sure to take their eyes, among the necessary home supplies of food.

If this new century of national life is to bring us peace, fruit must become a regular article of diet, along with meat, bread, and vegetables. General fruit culture means peace.

It will make one continuous garden of the whole world, and spread every man's table as the table of the Board of Agriculture is spread in this hall. It is the crying shame of some villages that they do not cultivate fruit more, and prevent their wild boys from harrying adjacent farms for it. What is a village lot worth that the owner cannot grow fruit on without a Chinese wall? The fear of fruit thieves is nothing but a bugbear. Let every land-owner in town or country assert his right to grow fruit, and use or sell it, and that difficulty will be done with. No man has a right to keep fruit rotting on the ground in the midst of thickly settled communities. That we must take care of our property or lose it, is according to the highest law.

Never till now, in any age of the world, could the farmer so well have fruit upon his table at every meal as we can. It was a dream of my boyhood that we might have it,—might reach that millennial state,—might realize that after-taste of the garden of Eden, and that dream has come true. Society, commerce, and trade are enlisted in making fruit plenty. We live in the woods, out of sight of any house, but the winter orange peddler finds us.

Fresh fruit is the great natural remedy for drunkenness. Ale, beer, cider, and wine have no hold upon the young people of this civilization, except in the absence of a cultivated taste for fruit. Those drinks furnish a poor but cheap and portable commercial substitute for lush fruit-juice. They belong to a dark age, and will go out of use when farmers make fresh fruit cheap and plenty at every street corner.

In respect of fruit eating, I think the city is leading the country. Wide-awake cities and villages are discovering that a fruit-eating population is more easily and cheaply governed than a beer-drinking population. Arrests for drunkenness and crime are not as common in a good fruit year. The more decent liquor dealers put fruit in the front end of their shops.

Growing strawberries for market still continues to pay the labor well, because so many of our people think twelve or thirteen months is such a very long time before a crop will come. "They won't bear this year, I s'pose," is the remark of thousands every spring.

There is one thing about our home supplies of food which could not so well have been understood at a farmers' meeting before chemistry came to the aid of agriculture. We do not, in this day of new commercial foods, always use scientific food. The old-time dyspeptic could only say, after eating too much short-cake, that she felt "a ter'ble goneness at the pit of the stomach." Now the enlightened housewife knows that carbon, as in fat, sugar, and starch, should be served with its due proportion of nitrogen, as in lean meat, cabbage, cheese or brown loaves, to repair the waste of living. She knows that the lamp of life burns more carbon in a cold day or a hard-working day than when the weather is warm or the workers are resting or going to bed. When in doubt what to feed us, she gives us some old-fashioned, hereditary dish that nourished our grandfathers. We are best fed and best pleased, on the whole, by food we are most used to, with slight variations once in a while. The race which changes its food may be beaten out of existence. Losing the excitement of the chase, the Indian has but a gluttonous appetite and no proper hunger for mutton or beef. Pent-up city people have to return to a savage camp once in a while, or lose their relish for fish and game. Hunger gives a keener zest to victuals than any sauce, but we should not forget condiments. Young stomachs may not notice every little omission, but old heads are aware that the wild deer made tracks to the salt-licks. Vinegar, as an appetizer, might often be as well mistaken for its chemical antecedent, alcohol, without any of the hurtful excitements of the latter.

There is wisdom in counsel. The need for this or that food changes with us every few years as we grow older. A staving good laboring Irishman told me the other day that he "couldn't ate a mouthful of mate to save his soul; I'm taking to oat-male and milk now," said he, "like a pig."

Of one who made the same complaint, a wise physician asked if a shake of red pepper was not forgotten with the meat.

A needful change of food is equivalent to medicine, because the proper shift precludes the dose by supplying the lacking element. Many eat an abundance of the wrong things.

The old-fashioned physician was very free to ask his *poorer* patients, "What the old Harry have you been eating?"

Pork and beans, fish and potato, pudding and milk, bread and cheese, or butter, or honey, or meat, or fruit were scientific foods when the only science was a common-sense of a thousand years standing.

It is curious that unfermented bread, religiously kept by the children of Israel, as a souvenir of their farming in the wilderness, should have been brought newly in vogue by dietic reformers, and often, by necessity, the hoe-cake is proven a righteous food for hunger.

Many housekeepers do not yet know the "gem," that delicious and tasty form of the old hoe-cake and the unleavened bread of the wilderness, wherever a cast-iron gem-pan can be transported.

Nothing but fresh milk or water, mixed or alone, is required for the rising, because the hot iron of the gem-pan generates steam enough to produce the desired porosity. There is no carbonic acid to injure digestion. Why carbonic acid, by the way, should be so injurious (?) in yeast-bread, and so harmless (?) in soda water, I never could see. We may notice, parenthetically, that when yeast-bread is toasted brown, so as to kill the yeast spores, then the most delicate invalid may partake of it.

The brown color of gems mixed with milk fairly ravishes an appetite. The beginner is liable to eat too many of them. The hot cakes are just the shape to split and take butter well. Their spongy inside fits them exactly for wet toast by entire immersion, or by partial dips, endwise, mouthful by mouthful, in cups of milk, coffee, tea, or chocolate. By making an aperture at one end of the hot gem and pouring in thin cream from the spout of the cream-pitcher, the daintiest of all farinaceous morsels is produced. Bite for bite and swallow for swallow with beef or pork-steak, mutton chops, veal cutlets, ham and eggs, broiled tripe, trusty hash, or cold corned beef, or cheese, or even ripe apples, pears, or grapes, quince-sauce, soup, fish, or fowl, or any comestible whatever, the hot, crisp gem fills the bill most gratefully, whenever a mouthful of bread is needed to qualify other food for digestion and assimilation. And yet there is no thanks to anybody for yeast ferment, chemical foam, or phosphatic reagency whatever.

Neither does the gem-pan call for any particular brand of flour or meal. Rye, buckwheat, oats, barley, maize, or wheat—no matter which, nor how ground or bolted, nor how much of a hurry the cook is in, it is all the same; the meal is as good so as any way, and the more hurry the better the cakes, so the batter be quickly stirred, whipped into bubbles by the hurry, the gem-pan sissing hot, and the oven a brisk one. A soapstone pan, if it needed no grease, might improve the gems for some people.

Out-of-door people must look sharp after a home supply of food for the lungs. Whether civilization tends to increase the amount of carbon in our outside atmosphere is more than I know. Probably it does around Pittsburgh, or any of our smoky cities, where thousands of tons of coal are sent into the air daily in the form of gas. Most certainly our present civilization increases the proportion of carbonic acid in the dwellings and work-shops of a crowded population.

Our New England people were originally selected, mostly from thick-settled communities, of course. But we may suppose that the larger number of our immigrating forefathers were of the more out-of-doors habit, and were fond of the open air by hereditary and immediate descent. None other would be so discontented in close quarters; none other would be so much attracted by the freer air of a new and unsettled country, where towns and cities had yet to be built, and might be built differently from the stinking towns and cities of the Old World.

Our ancestors came more naturally from the country then, and were out-of-doors people from the start. They were farmers, gardeners, teamsters, poachers, fishermen, sailors, hunters, foresters, and the like, to whom the wilderness was friendly, and to whom the broad canopy of the heavens offered a homely shelter. If by sympathy, family ties, and friendships it happened that delicate indoor people came over with the first immigration, no doubt they found life exceeding difficult, and were selected out of existence or into the growing centers of population. This must have been so in the old times, for we read in the current daily news that "many of the first settlers," in a recent colony of Swiss people on the Cumberland table lands, "were mechanics and factory operatives, who found pioneer's life too hard for them, and went away to the cities to work at their trades."

But now in New England the tables have been turning for a generation. Whereas, once the hungry air of the colonies was a little too bracing for the hot-house plants of Europe, now every dwelling, mill, school-house, and church is a hot-house, close enough to smother the out-of-door ambition of our out-of-door people. Now our open-air folks are being unwillingly and fashionably selected out of existence before they know it.

Our domestic animals will bear confinement better than those which are wild, and of so-called domestic animals there are breeds and families which may be kept closer than others. No one is too particular as to the atmosphere his swine live in, yet old-fashioned farmers and pork-raisers have a prejudice in favor of a broader pasture for pigs, thinking, if they do think, or philosophize, that exercise in the open air induces vigor and a feeding capacity which finally tends to much pork. But no good shepherd would shut up his sheep. Their wool keeps them warm; that would fall off or cease to grow if they were put in warm quarters. So the lungs of a sheep are never accustomed to carbonic acid. If a fleeceless sheep, used to the house, were called for by fashion and a market—as perhaps it has been—domesticated goats would probably fill the bill. Sheep notoriously sicken indoors, as any thoroughbred race of shepherds would.

The difference in the feathered tribes, as regards their endurance of confinement, will have occurred to every poultry fancier. Some delight in a dunghill, like the Asiatic fowl, where a grouse or quail of any tribe that we know would certainly die. At the outlet of a San Francisco sewer, near the end of the dry season, I saw 1,500 ducks penned together to fatten upon city garbage. We may try to imagine what a fearful substance the sewerage of a great city must be in a dry climate. And we may try to think how long the wild duck must have been domesticated and selected by disease and death before they would stay contented and thriving in such a place. The other bipeds—the sober-visaged, lantern-jawed Chinamen in charge, who brought swill from town balanced at the ends of poles, and lived as the ducks did, with a swashing plank across the green and fermenting cesspools between their respective hovels, seemed one of the ultimate products of a Philistine civilization. Given the cesspools, and these objects will certainly breed in them, for we read of 25,000 "sewer-rats" inhabiting the sewers of polite Paris.

I sketch the picture from life. It may be that a similar people, case-hardened and selected by ages of filthy surroundings, like intestinal worms, could be produced in New England. I sometimes think that this process is beginning, and already going on, by emigration, immigration, and the force of debasing popular habits. Already our living rooms, and especially our sleeping rooms, are in many cases tighter and closer than the mud hovels of our British ancestors. Those had wide-mouthed chimneys. Ours have the air-tight stove, a very modern invention, by which we gain in the consumption of fuel and lose in the consumption of life.

Our hardy progenitors lived much in the open air, male and female. If the farm kitchen was crowded of an evening, there was plenty of air for the young ones beneath the shingles of the attic, where the moon often shone in and the snow often drove in, and they lay tucked up warm in as good as an out-of-doors air all night long.

Did the children who went barefoot half the winter have constant colds and catarrhs in those days? Now the nasal tone of the patient Yankee farmer is heard, when the health of his family is enquired after, saying, "All well, excepting colds." He expects those and is resigned. He gets a great variety of them from his close school-houses, crowded by the children of races which endure carbonic acid better. His influenzas, bronchial difficulties, and pulmonary complaints are averaged, exchanged, and cross-bred in the village hall, and new, air-tight and dimly lighted church; the health maps of New England are sicklied all over with the blue cast of his consumption, because so little provision indoors is made for the open air animals the descendants of his forefathers ought to be.

What shall we think of the refinement and culture, not to say intelligence, of the people who try to nourish their blood in the effete atmosphere of each other's breaths for hours and hours? Do the extremes of society meet upon the same plane in respect of the air they choose to breathe?

A few—a very few—wealthy people of New England descent build a little larger rooms for themselves, but no building can possibly be big enough to give pure air to its inmates. A few modern mills and shops allow some breathing space for workmen, but except where intelligence to use our abundant means is greater than usual, our old style out-of-door population is selecting itself out of existence by impoverishing the food of its lungs and blood in the matter of oxygen.

Will you have more proof—more argument? Ask the veteran soldier if he ever got a cold in camp—no matter how often he lay down wet and got up smoking. Ask him if he ever had any of that catarrh till he came back from the war into a finished house. Ask the consumptive lad who slept himself to rugged health under a wagon all the way across the plains to California. Ask the few people who never have colds, and will not be caught long at a time in a close and crowded room. Ask your own judgment when you have fully considered these things, and accounted for the decay of the original hardy Yankee stock of New England.

The remedy is always at hand—plenty of clothes, food, and fuel, with open windows in sleeping-rooms after tucking head and ears in bed. With plenty of knowledge that certain races of men and species of animals must have clean air, we shall not be called upon to endure the shame of so much sickness in Connecticut.

Milk and blood differ little, chemically, but it seems odd to find the wan consumptives of our civil hot-beds lapping blood at our slaughter-houses like famished wolves.

An old farmer and teacher of this (Windham) county, aged ninety, whom I found sitting at his frugal repast of milk and bread, told me heartily that he didn't see but it tasted just as good as it did when he was a boy.

Countrymen, and especially out-of-doors people, should not allow themselves to be led too much by town notions in regard to food. For all that city folks can teach us many things. Five dollars might be well spent in treating a country family to a dinner at a first-class restaurant, so as to let them see what a clear and fragrant liquid coffee may be; how bread may be toasted without burning; how good hot coals and a gridiron makes mutton-chops and beefsteaks, and how quickly done, too; what a nice-looking dish is egg on toast, or the nature of a broiled mackerel, and the appropriateness of hot plates for roast mutton. Take the boys, if possible, to a grand restaurant, where the high steward has the manner of an archbishop, and let them see that supplying food is a chief business in life, and how those who will not help themselves to the choice bits must pay some one else to do it or go without.

Adjourned to Thursday, at 10 o'clock A. M.

SECOND DAY.

The Convention met at 10 o'clock on Thursday, December 18th, J. T. **Rockwell** of West Winsted in the chair.

The **Chairman.** I take great pleasure in introducing to you Dr. E. L. **Sturtevant** of South Framingham, Mass., who will address you on the "Food of Man," a subject in which you all take an interest.

SOME THOUGHTS AND FACTS CONCERNING THE FOOD OF MAN.

BY DR. E. L. STURTEVANT.

Life is distinguished from death by the presence of motion—of interstitial and general activity—of successions of actions which produce and promote a constant series of changes. The living cell is constantly engaged in maintaining its equilibrium or changing its structure and potentialities, and rules and is ruled as part of an aggregate whose motion it shares and to whose movement it contributes. To transfer the force which produces motion to the place where it is to act; the action of the conversion; the maintenance of the necessary machinery and functional processes—this constitutes the labor of living. Even more, there is a labor in the directing, whether originating and transferred through cerebral changes, or through ganglionic action, or through the reaction against impulses which are transferred from one point to another. The life of the parts and the life of the whole is only maintained by the reception of material from without, by the aggregation to itself of material from elsewhere than itself, in order that the forces expended in the vital motions may be renewed, and material for the repair of wastes be secured. Material for repair—power for action—this is the meaning of "Food."

The man is a machine whose economies may be studied in a mechanical way, by observation and experiment. Through the determination and measurement of wastes the wear and tear of action on the tissues may be estimated. Through the investigation of the changes which follow muscular action the expenditure of the power can be given, in figures which convey the relations of the force expended in this action to that taken in with the food. The coefficient of heat and motion is well known; the rapidity of transmissal of impressions by the nerves has been measured; in a word, the studies of physiologists have, through data based on experimental evidence, given much information concerning man, considered as a race, although lacking in many of the elements requisite to correctly deal with the man as an individual.

Confining our remarks at present to man as a machine, we cannot but admire the economy which attends his transference of force into motion as contrasted with the best machine of human make. Thus the available mechanical work of the steam engine is but one-twentieth of the heat produced by the combustion of coal, while in the human body one-sixth of the heat developed by the conversion of the bodily constituents may be utilized, according to the determinations of Haughton. And well for us is this economy, when we consider the amount of the labor of living, the demands of the human stomach, and the difficulty of obtaining regular supplies of food. In order that the human machine may perform external labor, the internal labor must be provided for, and this labor is great. Thus each beat of the heart is estimated as equal to a lift of 4.63 lbs. one foot high; and it is considered from the investigations of Donder that the work of respiration is 4.56 lbs. one foot high. As the average pulse is about 70 beats, and the average respiration about 18 per minute, these figures represent a work of about 406 foot-lbs. per minute, or 34,360 foot-lbs. per hour, or 584,640 foot-lbs. a day, and this sum does not represent the total labor requisite for the maintenance of the life. Per contra, the available labor that a working man performs is estimated, as a mean of numerous estimates, at 1,011,896 foot-lbs. daily. If we adopt the calculations of Letheby, we have the total ascertainable work, including actual labor, the work of circulation and respiration, but 1,610,412 foot-lbs., while the food taken is calculated to contain 7,720,000 lbs. of power. Thus the ascertainable work is about one-fifth the actual energy of the food; the four-fifths must be considered as contributing to the movements of the life.

If such are the relations of food to work as obtains among civilized man, where work is to be regularly accomplished, and where choice of foods exists to a certain and quite generous degree, it can be but a matter of conjecture as to the relations which obtain among more barbarous nations, where regular labor is scarcely practiced, and where supplies of food are often inadequate, and where there is variety, but limited choice of variety. A pound of fat supplies about two and a half times the force of a pound of starch; hence we cannot estimate the rations required by man by weight alone without reference to quality. At the temperatures of the arctics and the tropics, different amounts of food are requisite for the supply of the material for the maintenance of the animal heat, and a careful and rather close investigation of the habits of living and eating of the various races and nations of the globe satisfy the inquirer that there are relations between the food and the character of the man which cannot be accidental, which mutually influence the other, and which render nugatory the promulgation of a course of living towards which each man must conform.

We find blubber and meat the chief diet of the Esquimaux, who live above the limit of vegetable life; we find meat largely consumed by nations of tropical Africa, where the arid plains compel the life of the hunter in the stead of a settled habitation; we find rice the staple diet of the Hindoo; cassava and the banana leading foods in the tropics; fish, carrion, roots, herbs, barks—scarcely anything that is organic but has at some time or other been tried or used as food.

Yet in this variety of food we can see some general effects upon the populations. Abundance of food affects growth over scarcity of food. Flesh eating people usually display a quickness of motion over those who are vegetable eaters, and this seems illustrated by the greater fierceness of meat eaters over vegetable eaters in similar regions—seems, we say, as habits of life may be an influencing factor of greater consequence than we now deem.

The accounts of travelers from various regions of the globe all show that the variety of food substances is very great, and that the leading food supplies in any one civilized nation comprise but comparatively few substances, and that the substances in general use are determined in large part by the abundance, accessibility, or frequency of supply. Climate does not make man a meat eater except as forming the supply and cutting off the supply of other foods than meat; climate makes not the vegetable eater except as favoring the growth of vegetables; civilization forestalls wants, and by the surplus accumulated through the art of man affords choice of aliment to those who can buy, and hence mixed food, wholesome variety, and the luxuries of the palate; barbarism, having daily to contend for the day's supply, contents itself with what will support life, without much affectation of taste. In a word, the whole teaching of observation indicates as the leading fact about man and his food, that MAN EATS WHAT HE CAN GET, and not what he will, and that the man's life is modified by his food rather than the converse, although the mutual interaction between man the machine, and food the fuel, is very evidently direct. Man must have force, the machine must have fuel. When the food is insufficient, then there is deficient force, and man cannot develop the full capabilities of the machine. The good eater is hence the good worker, if we consider man as a race. Civilization is more productive than barbarism to the degree that it secures regularity and permanence of food supply, and such are the necessities of structure that concentration of nutritive material in the food seems coincident with the greatest development of human activity and progress.

We must note another circumstance, and a very important one too, in considering the variety of food substances—and an idea of the utmost importance in the consideration of the question of the natural food of man—and this is the effect of heredity in fitting a people for the utilization of the food to which it is accustomed. It seems unquestionable, if any one will take the trouble to investigate, that heredity has a most marked influence upon the feeding habits of a people. A food may be theoretically good, be available, and yet not come into general use, unless forced upon a people through their necessities. The general use of soup in France, and the little use of soup in the average American family, is an illustration; another is the mushroom, a fungi, one of the most nutritious and palatable of vegetables, scarcely known as a food, but only as a luxury in America, and yet in France, Germany, and Italy constituting the sole diet of thousands for weeks together; one species in Terra del Fuego forming the sole vegetable food of the natives; eaten by the natives of Alaska, of New Zealand, of Australia, but not, so far as I can learn, by the Indians of America. Mushrooms were held in detestation by the ancient Hindoos, the legislator Yama declaring that eating them, "whether springing from the ground or growing on a tree, fully equal in guilt to the slayers of Brahmen" (W. Jones). Among the Romans, Pliny notices those found growing at the roots of the oak as being highly esteemed in cookery; at the present time highly esteemed and entering largely into commerce as foods; in England highly valued for ketchups; and in 1876 dried mushrooms to the weight of 140 tons exported from the Tahitian islands alone.

It is certain that we people of New England could never emulate the eating habits of the various tribes of uncivilized man which we find placed on record, as our stomachs and our system are not fitted through hereditary structures and functions to compete with the range that we note.

Thus a native Australian, an attendant on Eyrie, consumed in one night 6½ lbs. of boiled meat, not including the bones, and could consume on the average 9 lbs. daily. Kane estimates the average Esquimaux ration in a season of plenty at 8 or 10 lbs. of flesh, with soup and water to the extent of half a gallon. We have here as extremes artic-America, and tropical and sub-tropical Australia.

Every Greenlander consumes on the average, according to Etzel, besides eggs, mussels, and vegetables, annually about 645 lbs. of fish and 784 lbs. of meat and lard. Strong young men consume daily, during several months, from 10 to 12 lbs.

of meat and a considerable quantity of biscuit. An Arowake lives in the field, according to Hillhouse, for three weeks or even a month on 10 lbs. of Cassava bread (obtaining other supplies precariously). The Guachos of South America, who pass the whole day in the saddle and lead a life of constant activity, resembling that of a carnivorous animal, scarcely ever taste anything but beef, and of this their consumption, as Carpenter writes, is by no means great. The regular daily allowance in rations for an employee in the Fur Company's service is 8 lbs. of buffalo meat, the whole of which, Stansbury says, is often consumed, and the old mountaineers seldom eat anything else. Sir George Simpson mentions an instance among the Yakuts of Siberia, when two of them devoured 72 lbs. of beef, and 36 lbs. of melted butter at a sitting. Per contra, the food of an average workingman's family in Massachusetts, according to the reliable statistics in the Massachusetts State Labor Bureau Report for 1875, is given as $81.48 worth of meat, $9.68 of fish, $20.38 of milk, and $310.63 of groceries. We may compare with these figures the rations of soldiers in India, constituted of 1 lb. of bread, 1 lb. of meat, 1 lb. of vegetables, and 8 ounces of rice daily.

Among civilized people, the students of dietetics are able to recognize a relation between the food consumed and the work performed, and tables have been carefully formed showing the nutrient ratios of various foods, and their relations to work; and as referring to people, under similar circumstances of nationality and habit, *i. e.*, heredity, have a certain fitness, but it is yet to be determined whether these conclusions can be applied with equal certainty to people under other conditions of life, such as exist in other climates, and in barbarous and semi-barbaric regions. In Britain, according to Letheby, 14.8 ounces of meat is used weekly by the indoor operative of London, 16 ounces weekly by the farm laborer of England, somewhat more by the Scotch, but 2½ ounces weekly by the Welsh laborer, and less by the Irish. Dr. Wynter computes the average meat consumption of London at not less than 30¾ ounces per head weekly. In Paris, according to Husson, the use is of rather more than 49 ounces weekly. Among the laborers of Massachusetts meat seems to be used to the extent of about 30 ounces weekly; if the population of the United States, assuming it to be 40,000,000, should consume in the same proportion, calculating in beef, it would require the slaughter annually of about 5,000,000 bullocks dressing each 800 lbs. of marketable meat.

The use of vegetable food offers a curious study. In the far north, we find note of a few plants used as salads, and among other resources, the maws of reindeer, with their half digested contents of willow bark and lichens. In some regions of Asia, rice the staple; of South America, the cassava and the banana. We also note that the greatest variety of vegetable foods are used where civilization does not furnish a steadfast supply, and where recurring periods of scarcity compel the utilization of whatever can be gathered from the field and forest that will support life. Thus, as an illustration of the variety that is evolved through the necessities of population, we can refer to the use of flowers and flower buds, a portion of the plant which finds but little use among the European nations—those of the cauliflower being the only general instance of flower buds in cultivation for vegetable use; and the caper plant, which furnishes flower buds for pickling. A few other plants furnish flowers, however, which are occasionally brought to table by Europeans, as for instance, of the borage, formerly in use as a salad in Queen Elizabeth's time, in England; of the marigold, used in broths and in soups in Britain and Holland; the caltha, whose flower-buds are used as a caper-substitute in the south, as Porcher states; of the cardamine, in South Carolina, along with the leaves, as a salad, according to Elliott; the holy thistle, the flower heads as an artichoke in Britain, as also those of the carline thistle; cloves, the unexpanded flowers of *Caryophyllus aromaticus*, as a spice; of the Judas tree, as a pickle in Canada, and in salads in North America, according to Don, and by the Greeks and Turks in salads, and in South Europe made into fritters with batter; of the cynara, the artichoke of Europe, and an esteemed vegetable in France; cytisus, the flower buds pickled as a caper substitute; the dahlia, whose petals may be used in salads, as Loudon states; galactitis, the flower stem while tender eaten in the region of the Dardanelles; of the magnolia, pickled in Devonshire, and considered exquisite in flavor; of melilotus, used for flavoring Gruyere cheese; the myrtle, the flower buds said, according to Lindley, to be used in Tuscany as a spice; the nuphar, whose flowers are used in cooling drinks by the Turks, according to Sibthorp; the cotton thistle, whose flower buds are used as an artichoke; of the oxalis, used in salads; of the cowslip primrose in Germany, as a tea, according to Klippart; the yellow-locust, whose flowers furnish a palatable dish when fried; the elder, whose flower-buds, according to Emerson, are an excellent caper-substitute when pickled; solidago, the golden rod, whose flowers are used in Pennsylvania as a tea, and in the south afford, according to Porcher, a pleasant and wholesome tea-substitute; red clover, whose powdered flowers are mixed with bread and eaten in Ireland, when food is scarce; of the nasturtium, used in salads; the bean-caper, whose flowers are used as a caper-substitute.

Every species mentioned here, it will be observed, can be classed as luxuries rather than as foods.

Of the instances we have among our notes of the use of flowers as food, we can group according to locality, as below:

AFRICA, EQUATORIAL.

Crotalaria glauca, Willd. The people of Madi eat its flowers, pods, and leaves as a spinage. (Grant.)

Cucurbita maxima, Duch. Pumpkin. The male flower, leaves and seeds eaten on the Upper Nile. (Grant.)

Leptadenia lancifolia? Dne. The natives of the Upper Nile make spinage of its flowers and tender shoots. (Grant.)

Nymphœa stellata, Willd. Water lily. Flowers and roots eaten by the Wahiyou. (Grant.)

Veltheimia sp. The flowers collected for spinage on the Upper Nile. Grant says they are very good, but too honey-tasting.

AFRICA, NORTH.

Cynara humilis. The receptacles of the flowers are eaten raw in Morocco. (Hooker and Ball.)

Cynomorium coccineum. It consists of a fleshy flower-stem about a foot in height, of a red color. In the island of Lancerrotte it is eaten by the natives. (J. Smith.)

AFRICA, SOUTH.

Aponogeton distachyon, Thunb. The scented flowering portion affords spinage at the Cape of Good Hope, and also a pickle. (Mueller.)

Hydnora Africana, a plant found growing on the roots of Euphorbia. It consists of a tubular flower from 4 to 6 inches long, and may be compared to the socket of a candlestick, but 3-lobed. The outside is of a dull brown, the inside of a rosy red color, possesses an offensive smell like putrid meat, but said to be eaten by the natives. (J. Smith.)

Mesembryanthemum emarcidium, Haw. The flowers are eaten by the Hottentots to quench thirst. (Thunberg.)

Melianthus major. The flowers are of a dark brown color, in long erect racemes, and contain a large quantity of honey, which is collected by the natives of the Cape of Good Hope. (J. Smith.)

ASIA.

Abutilon indicum. The flowers are eaten raw in Yemen, according to Forskal.

Caragana ulicina, Stock., var. *ambigua.* In Beloochistan the flowers are eaten by the Brahmins. (Brandis.)

Chamaerops Ritchiana, Grif. A small palm of Beloochistan and Afghanistan, whose young inflorescence is commonly eaten. (Seemann.)

Bignonia (*Spathodea*) *stipulata.* In Burmah, according to Mason, the flowers are brought to market for food.

Bombax ceiba. The fleshy petals of the flowers are sometimes prepared as food by the Chinese. (S. Wells Williams.)

Magnolia conspicua, the Yu-lan. The Chinese pickle the flower-buds, after the calyxes are removed, and use them for flavoring their rice. (Browne.)

Musa. The Chinese eat the flowers of the Banana pickled with vinegar. (Simmonds.)

Olea fragrans, Thunb. Lan-hoa. The sweet scented flowers are said to be used by the Chinese for flavoring teas. (Don.)

Rosa semperflorens, ? Monthly Rose. The Chinese serve the flowers, dressed whole, as a ragout. (London Hort. Trans., 1834, 262.)

Caryophyllus aromaticus, L. The flower-buds are the cloves of commerce.

Citrus. Orange flowers were served by the Japanese at the State dinner given to General Grant.

Ranunculus edulis, Boiss. The small tubers, together with the young stems and leaves of the blossoms, are brought to market in North Persia, and serve as food. It is called *Morch-serdag*, egg-yolk, on account of the yellow color of its flowers. (Unger.)

Agati grandiflora. In India the flowers are used in curries. (A. A. Black.)

Artocarpus Lakoocha, Roxb. In India the male spadix is pickled. (Brandis.)

Averrhoa bilimbi, L., and *A. Carambola*, *L.* The flowers are made into a conserve in India. (J. Smith.)

Bassia butyracea, Roxb. According to Drury, sugar made from the flowers is sold in the Calcutta bazaars. (Drury.)

Bassia latifolia, Roxb. The Mohwa tree of India. The succulent flowers fall by night in large quantities, are gathered in the morning, dried in the sun, and sold in the bazaars, forming an important article of food. They have a sickly sweet taste and smell, and are eaten raw or cooked. (Brandis.)

Bassia longifolia. The flowers are gathered as they fall, by the common people of Mysore, and are eaten raw or cooked, bruised and boiled to a jelly. They have a sickly taste and smell. (Brandis.)

Bauhinia purpurea, L., and *B. variegata.* The flower-buds of both species are eaten as a vegetable, and often pickled in India. (Brandis.)

Bombax malabaricum, DeC. In India the calyx of the flower-bud is eaten as a vegetable. (Brandis.)

Calligonium polygonoides, L. The Abortive flowers, which fall in great numbers, are in the South Punjaub, and sometimes in Sindh, swept up, made into a bread, or cooked with ghee, and eaten. (Brandis.)

Capparis aphylla, Roth. In the Punjaub the buds eaten as a potherb. (Drury.)

Clerodendron serratum. In India, the flowers eaten. (Pickering.)

Dillenia pentagyna, Roxb. The flower-buds and young fruit have a pleasant acid flavor, and are eaten raw or cooked in Oude and Central India. (Firminger.)

Dioscorea bulbifera. In India the flowers and roots eaten by the poorer classes. (Pickering.)

Orthanthera viminea, Wight. The flower-buds, raw or cooked, are eaten as a vegetable in India. (Brandis.)

Periploca aphylla. The flower-buds are eaten, either raw or cooked, as a vegetable in India. (Brandis.)

Rhododendron arboreum. The scarlet flowers contain a quantity of honey, which in Nepal is made into a jelly. The flowers are eaten also in India, and are made into a pleasant sub-acid jelly, but they are at times intoxicating. (Brandis.)

Sesbania grandiflora. About Bombay cultivated for its large flowers and pods, both of which are eaten by the natives as a vegetable. In the Philippines its flowers are also cooked and eaten. (Graham. Blanco.)

Smilacina. A species of the Himalayas, called "chokli-bi"; has flower heads sheathed in tender green leaves, which form, according to Hooker, an excellent vegetable.

EUROPE.

Borago officinalis, L., Borage. In cooling drinks. (M'Intosh.)

Brassica oleracia, *Botryapis cauliflora*, DeC., the Cauliflower. The heads or flowers considered by M'Intosh to be one of the greatest of vegetable delicacies.

Calendula officinalis, Marigold. The flowers are used in Britain and in Holland in broths and soups, according to Loudon.

Capparis spinosa, L., Caper tree. The flower buds pickled in vinegar form the capers of commerce.

Carduus marianus, Holy thistle, milk thistle. The heads of the flowers used as an artichoke. (Loudon.)

Carlina acanthafolia, All, and. *C. vulgaris*, L., the Carline thistle. The receptacle of the flower used as an artichoke. (Loudon.)

Cercis siliquastrum, L., Judas tree. The flowers are of an agreeable acid taste, and are sometimes used in salads, or made into fritters with batter, and the flower buds pickled in vinegar. The flowers are also used in salads, to which they give an agreeable odor and taste, by the Greeks and Turks. (Johns. Walsh.)

Cynara scolymus, L. The flower heads form the artichoke, an esteemed vegetable in France.

Cytisus scoparius, Link. The flower buds sometimes pickled as capers. (Don.)

Dahlia. The petals may be used in salads, according to Loudon.

Galactites tomentosa. Around the Dardanelles, Forskal states the flower stems to be eaten while tender.

Helianthus annuus, L., Sunflower. The fresh flowers, when a little short of full bloom, furnish a dish for the table which bears favorable comparison with the artichoke. (Grunert.)

Magnolia grandiflora. The flowers are pickled in some parts of Devonshire, and are considered exquisite in flavor, according to Loudon.

Melilotus officinalis, Willd. The flowers and seeds of this plant are the chief ingredients in flavoring Gruyere cheese. (Don.)

Myrtus communis, L., the Myrtle. Lindley says the dried fruit and flower buds are said to be used in Tuscany as a spice.

Nuphar lutea, Smith. The flowers are used by the Turks in the preparation of a cooling drink. (Sibthorp.)

Onopordon acanthium, L., Cotton thistle. The flower heads are used as an artichoke. (Loudon.)

Oxalis deppei. The flowers are used in salads and for garnishing. (Loudon.)

Primula veris, the Cowslip primrose. Flowers used by the poorer classes of Germany for making a tea, according to Klippart.

Robinia pseud-acacia, Yellow locust. Merat says the flowers furnish a palatable dish when fried.

Tilia Europœa, L. The flowers and leaves are used as a tea substitute. (Browne.)

Trifolium pratense, L., Red clover. In Lightfoot's Flora Scotica it is said that in Ireland when food is scarce the powdered flowers are mixed with bread and eaten.

Tropœolum majus, L., and *T. minus*, L., the Nasturtium. Flowers may be eaten in salads, as Loudon observes.

Zygophyllum fabago, L., Bean caper. Balfour says the flowers are used as a caper substitute.

NORTH AMERICA.

Caltha palustus, var. *parnassifolia.* The flower buds are pickled for use as a substitute for capers in the Southern States, according to Porcher.

Cardamine hirsuta, L. Elliott says the leaves and flowers of the common bitter cress are eaten as a salad.

Cercis Canadensis, L., Red-bud, Judas tree. In Canada the French pickle the flowers, and in North America they are frequently used in salads, according to Don.

Sambucus Canadensis, L., Elder. Emerson says the unopened flower buds, when pickled, form an excellent caper-substitute.

Solidago odora, Ait., Golden rod. The dried flowers make a pleasant and wholesome tea substitute, according to Porcher. They are thus used in Pennsylvania (Am. Nat., 1879, 345).

Asclepias cornuti, Decais. A sugar is said to be prepared from the flowers. (Masters.)

Asclepias tuberosa, L. The Sioux Indians of the Upper Platte prepare from the flowers a crude sugar. (Dept. Agr. Rept., 1870, 405.)

Yucca baccata. The young flower buds, when about to expand, are roasted by the Indians of Arizona, New Mexico, and Utah, to be eaten. (Dept. Agr. Rept., 1870, 418.)

Chamaedora tepejilote, Lieb. The flowers, when still enclosed in the spathes, are highly esteemed as a culinary vegetable in Mexico, known as "tepejilote." (Seemann.)

SOUTH AMERICA.

Abutilon esculentum, St. Hil. In Brazil the inhabitants dress and eat the flowers with their viands. (Don.)

Carolinea (*Pachira*) *princeps*, L. fil., and *C. insignis*, Swartz. The young leaves and flowers serve as a vegetable food in Guiana. (Unger.)

Chamædorea elegans. The young, unexpanded flower spikes are said to be used as a vegetable in South America.

Porcella nitidifolia, Ruiz et Pav. The berries as well as the flowers are eaten in Peru. (Don.)

Spondias mombin. In Brazil the flower buds are used as a sweetmeat with sugar. (Masters.)

Talauma Plumiera, Serz. The flowers are used by the distillers of Martinico to sweeten liquors. (Don.)

NEW ZEALAND.

Areca sapida, Soland. In New Zealand the natives eat the young inflorescence. (Seemann.)

In the United States about seventy or seventy-five species of plants are represented in our best seed catalogues for garden use. Burr's "Garden Vegetables" enumerates seventy-three species, or so-called species. Robinson, for France, gives a list of some vegetables grown or used in France, which counts up seventy species. Loudon, in the "Horticulturist," gives a catalogue of culinary vegetables, one hundred and forty-six species, many of which, nay the majority of which, are not in general cultivation. Indeed, but few gardens in New England grow more than twenty-five or thirty of the species enumerated in our seed catalogues. If, however, our civilization should retrogress, and necessity force us to seek our daily food from the meadows and woods, we should find included among our food many of our weeds and of our wild fruits, and our number of vegetable foods might possibly increase to the number enumerated for China by the "Anti-famine Herbal," a book said to be published for gratuitous distribution in those districts which are most exposed to natural calamities, and which contains the description and representation of four hundred and fourteen different plants whose leaves, rinds, stalks, or roots are fitted to furnish food for the people when drought, locust ravages, or inundation have occasioned a failure of rice and other grains.

How many nutritious vegetables are known it would be difficult to say. Professor Unger in his "Plants Used as Food by Man," enumerates nearly eight hundred species, and says, "If we bear in mind, however, that we are far from being acquainted with all the nutritious vegetable substances which are or may be drawn by man into the circle of his domestic economy, we may estimate the entire number of such species of plants at one thousand." This, however, is far below the actual facts, as our own notes, which are by no means complete, enumerate at date eleven hundred and five genera, and twenty-eight hundred and one species of plants which afford food to man; and although it is probable that some of these species are duplicates under different names (synonyms), yet we have species which we have as yet left unrecorded which will more than make up the deficiency, and we believe the number could readily be brought to thirty-five hundred or more, by a more complete research of records.

Among the curiosities of vegetable food may be reckoned those coarse substances which, to the civilized man, are neither objectionable from their repulsiveness or strangeness, but simply from their apparent lack of nutritive property, and from their affording no gratification to the taste; and those other foods which are furnished by plants considered poisonous, and which generally are poisonous in their raw state.

Who would suppose that sawdust is edible? Yet in Norway and Sweden the sawdust of non-resinous woods, like beech and birch, is boiled in water, baked, and then mixed with flour to form the material for bread. In this connection we may quote from Professor Storer, who says, "Curiously enough the chemical evidence goes to show that it is for feeding animals rather than for feeding plants that sawdust might be put to use. It has, in fact, been shown practically by the experiment of Stockhardt and his pupils, that fresh sawdust, even that of pine trees, can be used with advantage as fodder in times of dearth."

If sawdust can be put to food use, it need not surprise us that the Indians of British Guiana mix the starch of the Greenheart seeds with rotten wood to form a disagreeable kind of bread; nor that the Veddahs of Ceylon mingle the pounded fibers of soft and decayed wood with the honey on which they feed when meat is not to be had.

The use of bark as food is usually associated in civilized life with spices or flavoring substances, yet we find the following species furnishing in their bark, if not always staple foods, yet probably often of the highest importance to the starving natives of the starveling regions:

Abies. See *Coniferæ.*

Acacia leucophloea, Willd. In India the bark is ground and mingled with flour, during periods of scarcity. A spirituous liquor is distilled from the bark in the Sholapore district, and on the Coromandel coast the natives mix the bark with palm wine and sugar to obtain the ardent spirit.

Atherosperma moschata, an aromatic tree of New Holland, furnishes a tea substitute, according to Henfrey, from a decoction of its bark.

Brugueria gymnorhiza. The bark eaten by the natives of the Malayan archipelago, according to Persoon.

Calycanthus floridus, the Carolina allspice. The aromatic bark is said to be used as a substitute for cinnamon in the United States.

Canella alba. Canella bark, the liber of this West Indian tree, has the properties of a medicine and a spice.

Celastrus scandens, L. The Chippewa Indians use the tender branches. It has a thick bark, and is sweetish and palatable when boiled.

Cinnamomum zeylanicum furnishes in its bark the spice known as cassia. It is a native of Ceylon, and has also been carried to other regions. Cinnamon is also collected from other species, as *C. cassia*, *C. culilawan*, etc.

Coniferæ. The Norwegians prepare a bread from the inner bark of *Pinus sylvestris*, according to Balfour; the Laplanders and Finns make also a bread with the triturated internal layers of the bark of the pine. The Indians of Alaska strip off the outer bark of *Pinus contorta*, and scrape off the newly formed cambium from the trunk, and eat the scrapings either fresh or dried. It has a coarse look, but when fresh, as Dall observes, is not unpleasant, although it acts as a gentle laxative. As the season advances it becomes strong in turpentine. The Oregon Indians collect the cambium of the *Thuya gigantea* in the same manner. According to Mr. Kenzie, the Indians of the west likewise employ the inner bark of the Hemlock, *Abies Canadensis*, for food. It is taken off early in the spring and made into cakes, which they eat with salmon oil and consider almost as a dainty. *Abies larix*, the Larch, according to Wrangell, furnishes a food to the Jakuts of Northern Siberia, who grate the inner bark and use it in a broth of fish, meal, and milk; they also use the bark of the Fir in a like manner.

Dicypellium caryophyllatum, a tree of the Brazils, furnishes clove bark, used in a ground state for mixing with other spices.

Drimys granatensis, L. fil. var. *montana*, St. Hil. In Brazil, Don states, the bark is used as a seasoning. It is known in medicine as Winter's bark.

Hibiscus tiliaceus, L. (*Paritium tiliaceum*, St. Hil.) Seemann says the Tahitians used to suck the bark when the bread-fruit harvest was unproductive, and that the New Caledonians ate it.

Mespilodaphne pretiosa, a Brazilian tree, yields a bark whose properties, as Henfrey states, are similar to those of cinnamon.

Pinus. See *Coniferæ*.

Quercus. The pounded bark of the Oak, as Professor Brewer writes me, is used as a food by the Digger Indians.

Salix. The half digested willow twigs of the reindeer's stomach, forms a great delicacy for the Esquimaux of Alaska. This "gruesome mass" is dried for winter use. It is eaten as a salad, and is no doubt, Dall observes, a powerful antiscorbutic.

Santalum persicarium, a small tree of the Sandal wood species, furnishes in the bark of its root a very nutritious but tasteless food to the Murray tribe of Australians. It is roasted in hot ashes, and eaten. The native name is "Quantong."

Thuya. See *Coniferæ*.

Zanthoxylum piperitum, DC., native of Japan. The bark is used in soup instead of spice.

Of poisonous foods, we may mention the bitter cassava, the whole tribe of arums, and indeed very many other species in a raw state. In these instances the poisonous ingredients are volatile and are expelled by heat, thus converting what was before acrid and uneatable into a healthy diet. We have however one curious instance in the colocynth, a drug formed from the pulp of the *Cucumis colocynthus*, so drastic that a teaspoonful and a half of its powder, when taken, has produced death; yet in South Africa, according to Drury, the seeds constitute an important article of diet; in the north of Africa, according to Captain Lyon, the seeds are used as food. The pulp is said to be eaten by buffaloes and ostriches, but is unfit for human food, as Flueckiger states, but the seed kernels, freed from pulp by roasting and boiling, and subsequently deprived of their coatings, are used as food by some of the tribes of the desert. Stille says that at the Cape of Good Hope colocynth is said to be eaten by the inhabitants as a pickle without injury, and in India, according to Vaupell, there is a sweet variety which is edible and cultivated. There are many other fruits poisonous in one portion and edible in another, and quite a long and interesting list could be offered did space allow.

We will now close this desultory paper on foods by reference to the use of insects—a food which to us seems disgusting; yet why we should eat the lobster which fattens on carrion, and the pig which is grown on offal, and be unwilling to eat the various worms which are hatched in the midst of the clean vegetables which constitute their food, we cannot say, except that the fact remains, and curiously enough the use of insect foods is found to exist but rarely among the common people of civilization, but is confined to either the epicure developed by luxury, or the savage compelled by want. We will arrange our list alphabetically, and will not attempt a strict entomological division.

Ants. These have, as Kirby and Spence write, no unpleasant flavor; they are very agreeably acid, and the taste of the trunk and abdomen is different. A kind of red ant is eaten fried in Burmah, as Simmonds writes. Bates says that on the Tapajos river, a tributary of the Amazon, the Indians, when food is scarce, season their sauce made of mandioc juice with the Sauba ants. Humboldt observed a kind of ant called *vachacos*, dried and blackened by smoke and made with a kind of white paste with black spots, eaten by the Indians. Lander informs us that ants are eaten by the natives of Yariba in Africa, stewed in butter, and Piso speaks of the yellow ant called *cupia*, inhabiting Brazil, and whose abdomens serve as food, as well as of another species under the name of *tamajoura.* In seasons of scarcity, the Bushmen of the Orange river subsist in great measure upon ants and their larvæ. Cameron, in his "Across Africa," describes the method of catching the ants, and of smoking them over slow fires to preserve them for food.

The Digger Indians of California and the plains feed upon ants, catching them by spreading a dampened skin or fresh peeled bark over their hills, which immediately attract the ants to its surface. When filled the cover is carefully removed, and the adhering insects shaken into a tight sack, where they are confined until dead, and are then sun-dried and laid away. Bushels are thus gathered annually.

The white ant (*Termites*) affords an abundant supply of food to some African nations. They are eaten, either raw or boiled, by the Hottentots (Sparrman). Livingstone says that when the white ants fly against a roof built over their nest they tumble down in a shower, and their wings instantly become detached from their bodies. They are then helpless, and are swept up in baskets to be fried, when they make a very palatable food. In the East Indies they are also collected and eaten. Mr. Smeathman thinks them delicate, nourishing, and wholesome, when parched in iron pots over a gentle fire. The Hindoos suppose that the female white ant, in particular, possesses highly nutritive properties. In Western Australia the natives collect the young of the Termites from their nests and eat them. From the fat thick bodies of the male white ant the Monbuttoo tribe of Central Africa boil out a greasy substance, which is liquid and transparent, and has a taste perfectly unobjectionable, as Schweinfurth writes.

In some parts of Sweden the common ants are distilled along with rye to give a flavor to the inferior sorts of brandy, as Coursett states in his "Travels in Sweden."

The white ant belongs to the natural order NEUROPTERA, while the true ant belongs to the natural order HYMENOPTERA, but for our purpose we group together according to the common names.

Bees. Bees are eaten by various people, and the Moors in West Barbary esteem the honey-comb with young bees in it as delicious; but by one witness it has been spoken of as insipid to his palate, and as having sometimes given him heart-burn. (See Trans. of Ent. Soc , iii., Enc. Brit., 9th ed., ix.) Knox informs us that bees are eaten in Ceylon. The Javanese bee, *Apis dorsata*, is valued by the natives for its larvæ, which they use for food. When pressed by hunger Du Chaillu, in Equatorial Africa, says: "Every one, myself included, at once sat down and devoured honey, wax, dead bees, worms, dirt, and all, and our only sorrow was that we had no more."

Beetles. The Goliath beetles are said to be roasted and eaten by the natives of South America and Western Africa. The Mexican Indians, according to M. Vasselet and Madame Salle and her son, prepare a liquor from a beetle, *Cicindela curvata*, by macerating it in water or spirit, which they apparently use as a stimulating beverage. The Papuans of New Guinea, according to Wallace, eat beetles. Curtis says that the Turkish women cook and eat a certain beetle, *Blaps sulcata*, in butter, to fatten themselves, and Dr. Clarke relates that the Egyptian women eat the sacred beetle, *Scarabæus sacer*, believing that it renders them prolific. The eggs of a water-beetle, *Corixa femorata*, in Mexico, are said to be gathered from the water-plants and used as an article of food by the dwellers near the lake where they abound. The natives make bundles of sedges, which are removed to the lake, Texuco, and floated on the water until covered with eggs; the bundles are then taken out, dried, and beaten over a cloth. The eggs being thus disengaged are cleaned, sifted, and pounded into flour. (Dept. Ag. Rept. 1866, 38.)

Butterflies. The natives of New Holland eat a kind of butterfly called "bugong," and the natives of Australia eat a kind of butterfly, as Simmonds avers in his "Curiosities of Food." See *Moths.*

Caterpillars. These were eaten by the ancient Romans, and although not a regular article in European markets, are yet occasionally eaten by Europeans under necessity. Thus Livingstone in his South African travels says that although his family suffered considerably from scarcity of meat, they did not suffer from absolute want of food. This want was felt more especially by his children, and the natives, to show their sympathy, often gave them a large kind of caterpillar, which they seemed to relish. These insects could not be unwholesome, he remarks, for the natives devoured them in large quantities themselves. Again the same traveler says: "A large caterpillar, called 'nato,' feeds by night on the leaves of an acacia, and comes down by day to bury itself at the root in the sand, in order to escape the piercing rays of the sun. The people dig for it there, and are fond of it when roasted, on account of its pleasant vegetable taste. When about to pass into the chrysalis state it buries itself in the soil, and is sometimes sought for as food even then." "The 'lopane,' large caterpillars three inches long, which feed on the leaves of the 'mopane' tree, are eaten." Among the delicacies of a Boshiesman's diet, Sparrman mentions the caterpillars of butterflies. The Chinese eat the caterpillars of a hawk moth, (Sir G. Staunton's Voyage, iii., 296,) some of which tribe Dr. Darwin (Phytol., 364,) says are, in his opinion, very delicious. The caterpillars in China affected by the fungus, *Sphaeria sinensis*, are there collected into small bundles, and sent to market and sold. The Australian savages constantly eat caterpillars, for which they have a great partiality, and the natives of New Holland eat the caterpillars of a species of moth which feeds at night. The Digger Indians eat a kind of green caterpillar, about a finger long. See also *Tobacco Worm.*

Centipede. Humboldt has seen the Indian children drag out of the earth centipedes eighteen inches long, and more than half an inch broad, and devour them.

Cicada. Aristotle says that the cicada was eaten by the most polished Greeks, who accounted them delicious. Athenaeus and Aristophanes mention their being eaten, and Ælian is indignant that these insects, sacred to the Muses, were strung, sold, and eagerly devoured in his own time. Pliny says that the Eastern nations, even the wealthy Parthians, used to eat them. The imago of *Cicada septemdecem* is now eaten by the Indians of North America, who pluck off the wings, and then boil the insect. The aborigines of New South Wales formerly used various species, eating them raw after stripping off the wings.

Cockchafers. In 1688 immense numbers of cockchafers appeared in the county of Galway, in Ireland, where their grubs are called Connaught worms, and were eagerly devoured by swine and poultry. This fact being observed by the people, they adopted a mode of dressing these insects, and then ate them themselves. (Phil. Trans., xix.)

Crickets. Mr. Swainson says that the natives of Africa regard as delicious food the roasted females of a certain kind of cricket when full of eggs, which are enclosed in a bag, and resemble a fish's roe. At the proper season the children are always busily employed in digging these pregnant specimens out of the earth to gratify the palates of themselves and parents. The tribes of Oregon Indians, in America, mix the various berries that they collect with crickets dried and pulverized for a food. Father Baegart also speaks of crickets being eaten by the Digger Indians of California.

Earthworms. Professor Letheby is responsible for the statement that at a Chinese dinner served in good style to some English visitors, there were served salted earthworms. The Indians of the Rio Negro, according to Wallace, eat large earthworms, which, when the lands in which they live are flooded, ascend trees, and take up their abode in the hollow leaves of a species of Tillandsia, where they are often found accumulated by thousands. See also *Worms.*

Flies. About the lakes of Mexico there abounds a species of two-winged fly, which the natives call Axaycat'l, and the eggs of which being deposited in immense quantities upon the rushes and flags form large masses, which are taken up by the fishermen to sell in the market. This sort of caviare is baked in cakes, and has much the same taste as the caviare of fish. It was a favorite food of the Indians long before the Conquest. Father Gage, in his "Travels," says that, "at one season of the year the Indians had nets of mail, with the which they raked off a certain *dust* that is bred on the water of the lake of Mexico, and is kneaded together like unto *oas* of the sea. They gathered much of this and kept it in heaps, and made thereof cakes like unto brick-bats, and they did not only sell this ware in the market, but also sent it abroad to other fairs and markets afar off; and they did eat this meat with as good a stomach as we eat cheese." It is not despised, says Fennell, from whom we quote, even at fashionable tables in the capital, and is now a common dish among the Spaniards as well as

Mexicans, who eat not only the eggs but the flies themselves, mixed up in a mass and prepared with saltpeter.

On the borders of Mono Lake, in California, a large fly deposits its eggs in the frothy edge of the surface, each of which when hatched becomes a larva of considerable size, and is called Ke-chah-re by the natives. These larvæ when dried and pulverized are mixed with meal made of acorns, to be sun-dried or baked as bread, or mixed with water and boiled with hot stones for soup.

In the Tuna lakes of Fezzan are found a species of brine shrimp, called the "Fezzan worm" in Dood. These are caught with cotton nets, in which are hauled up innumerable other insects and flies, with which the lake is filled. The whole is mixed with a red kind of date and made into a paste, which has a smell and taste similar to salt herring, and is eaten.

Dr. Livingstone speaks of a cake called in Africa "Kungu," made of midges. He writes as follows: "But next morning we sailed through one of the clouds on one side, and discovered that it was neither smoke nor haze, but countless millions of minute midges called "Kungu" (a cloud, or fog). They filled the air to an immense height, and swarmed upon the water—too light to sink in it. . . . . The people gather these minute insects by night, and boil them into thick cakes, to be used as a relish—millions of midges in a cake. A Kungu cake an inch thick, and as large as the blue bonnet of a Scotch plowman, was offered to us; it was very dark in color, and tasted not unlike caviare, or salted locusts." In another place our traveler speaks of these eatable insects, "Kungu": "They are caught by a quick motion of the hand holding a basket."

In northeastern India a very common hemipterous insect, *Erthesina*, is largely eaten by the Naga Hill tribes.

The Indians of Chasuta, Eastern Peru, "eat mosquitoes, that they catch on their bodies, with the idea of restoring the blood which the insect has abstracted," as Herndon writes.

Grasshoppers. The Greek poor were accustomed to feed on grasshoppers, while the still more poverty-stricken Digger Indians of the present day catch them in large numbers, eating them either ground and put into soups or mushes, or baked and eaten as shrimps. They also pound them up with service, hawthorn, and other berries, and, made into small hand-pressed cakes, are dried in the sun for future use. In some parts of Madagascar, as Ellis states, grasshoppers are collected, cooked, and eaten as food, or offered for sale.

Grubs and Larvæ. The larvæ of various species of beetles are eaten in different parts of the world. The grubs of all the African beetles that feed upon decayed wood Smeathson affirms to be rich and delicate eating. The grub of the palm-weevil, *Cordylia palmarum,* the Grou-grou of the West Indies was eaten in olden time in India, and is now eaten in the West Indies. The grub of *Priomus damiorum,* which is of the thickness of a man's finger, is eaten in Surinam, and the West Indies both by whites and blacks, who empty, wash, and roast them, and pronounce them delicious. Madam Merian, in her work on the insects of Surinam, says the natives of that country roast these grubs and eat them with great enjoyment, and Stedman says these grubs are a delicious treat to many people, and are regularly sold at Paramaibo, and in taste savoring of all the Indian spices, as mace, cinnamon, cloves, nutmeg, etc. The Rev. Lansdowne Guilding says the cabbage-palm grubs are eaten by a few persons in Surinam, that they are fried in butter, and that the greedy epicure, holding the head between his fingers, sucks out the fat entrails. Even some Englishmen seem fond of these grubs, when properly cooked.

In Surinam, in America, and in the West Indies, not only the black but even the white inhabitants wash and roast the grubs of the *Cerambyx damicornis,* and then eat them as a luxury, according to Madam Merian. This grub is called *macauco* in Jamaica, where it is in request at the first tables. A similar grub is dressed and eaten under the name of *moutac* both by whites and blacks at Mauritius. According to Linnaeus the grubs of *Cerambyx cervicornis* are held in equal distinction.

The larvæ of the Capricorn beetle are accounted very great delicacies in many countries. This is particularly the case with the grubs of the *Macrodontia cervicornis,* known throughout Brazil and Cayenne by the name *mouche scieur de long.*

F. W. Hope says that some of the native tribes of India, in the vicinity of Travancore, and in the island of Ceylon, feed on the grubs of Lamideæ, as is the case in Africa with *Lamia gigas*, while Smeathman says the roasted grubs of *Lamia trilobus* are eaten in Africa.

In Australia a large grub which inhabits the wood of the gum trees is a favorite food of the blacks. In New Caledonia the larvæ of *Malledon costatus*, found in the dry trunks of the *Oncocarpus Vitiensis* furnish an esteemed food to the natives, according to Seemann.

In order to acquire that plumpness which is deemed in the East a beauty, the women of Arabia and Turkey swallow every morning three specimens of a Tenebrio dug out of the filth of the garden and fried in butter, on authority of Fennell.

Among the ancients, the Romans ate a grub called Cossus by Pliny, which he tells us lived commonly in the oak, and used to be fattened with flour by the Roman epicures; and Ælian mentions an Indian king who set before his Grecian guests some roasted worms taken from a plant, probably the grubs of *Cordylia palmarum*, and the Grecians found them delicious.

The larvæ of an enormous hornet, *Vespa magnifica*, Lin., called Vok by the Lepchas of India, is said to be greedily eaten by them, as are those of various allied insects.

See *Ant*, *Bee*, and *Flies* for larvæ; also *Worms*.

Lice. Kirby and Spence state that lice are eaten by the Hottentots and natives of the western coast of Africa. Andersson writes of the natives of Walfisch Bay: "One fine morning I observed an individual attentively examining his caross spread out before him in a sunny and sheltered spot. On approaching him in order to ascertain the cause of his deep meditation, I found, to my astonishment and disgust, that he was feasting on certain loathsome insects that cannot be named to ears polite."

Locusts. The custom of feeding upon locusts is general throughout the East, and has been observed in not only Africa and Arabia, but in the Malay peninsula as well, and in Burmah, etc., and also less frequently in Europe and America. On the Nineveh sculptures are represented men carrying different kinds of meat to some festival, and among them some who carry long sticks to which are tied locusts, as Riley states in his article on "Locusts as food for man." They are counted among the "clean meats" in Leviticus, xi., 22, and are referred to in other parts of the Bible as food for man.

We have a number of opinions in regard to their taste. The Abbe Godard says that fried in oil they are not bad. Livingstone says that they are strongly vegetable in taste, the flavor varying with the plant on which they feed. Boiled they are disagreeable, but when roasted are preferable to shrimps. Prof. Riley says from personal experience that the flavor of the raw locust is most strong and disagreeable, but that of the cooked insect is agreeable, and sufficiently mild to be easily neutralized by anything with which they may be mixed, and to admit of easy disguise, according to taste or fancy. Hasselquist says when boiled well in water and afterwards stewed in butter they form a fricasee of no bad flavor. Andersson has tasted locusts prepared in various ways, but is not disposed to call them palatable. Shaw says they taste like crawfish. Mr. C. Horne writing to "Science Gossip," says he served a curry and croquet of locusts to two gentlemen as Cabul shrimps, which in flavor they very much resemble; but the cook having inadvertently left a hind leg in a croquet, they were found out to the infinite disgust of one of the party and the amusement of the other. The Rev. R. Sheppard, according to Fennel, caused some of the common green locusts in England to be prepared by boiling and frying, and pronounced them excellent food. Chenier says they possess "an oily and rancid taste which habit only can render agreeable."

Most of the Arabs, except those of Sinai, eat species of locusts, and they are sold in the markets by measure. The Jewish Arabs believe that the food of which the Israelites ate so abundantly in the desert was showers of locusts. Hasselquist says the Arabs form the locusts into a flour by grinding or pounding. Chenier says they are brought to market in Morocco in prodigious quantities, and the Abbe Godard says they are bagged, salted, and dried for consumption. Riley is informed by one who has passed some time in Morocco that they are now used extensively at times as a food there, and are brought into the Tangier market for sale, and says the Jews, who form a large part of the population, collect the females only for food—having an idea that the male is unclean, but that under the bodies of the females there are some Hebrew characters which make them lawful food. The Abbe Poiret also states that the Moors not only eat them, but that they are publicly exposed for sale at Tunis and other towns. When Jackson was in Barbary in 1799, dishes of locusts were generally served up to the first tables and esteemed very delicious. Shaw also speaks of their use.

In Africa their use as food is mentioned by Livingstone in his missionary travels. Andersson says, that in Damara land they are eaten after being partially roasted, either fresh or dried. The Hottentots, according to Sparrman, visibly fatten on them, and make a coffee-colored soup of their eggs. In Madagascar, according to Ellis, the locusts are gathered in baskets, and are then shaken from one end to the other of a long sack to detach the wings and legs. They are then winnowed, and the bodies dried for future use, or fried in fat. Dampier states they are used as food in the island of Timor.

The Romans are said to have used locusts by carefully roasting them to a bright golden yellow. They seem also to have been sold as food in the markets of Greece (Pliny). They are now extensively used as food in southern Russia, as Riley is informed.

In the Mahratta country, India, Kirby and Spence were informed they were salted and eaten by the common people.

In North America they are eaten by many of our Indian tribes, notably the Snake and Digger Indians of California. Fires are lit in the path of the swarms, the wings and legs crisp up and are separated, and the bodies are then eaten fresh, or dried in hot ashes and put away for future use. They are also eaten pounded to a meal, and mixed with pounded acorns, or with berries to be made into cakes.

We give a few references to where information concerning the use of locusts as a food may be found.

Andersson: "Lake Ngami," p. 227; A Mission to Ava; Bochart: Hierozoicon, ii. lib. iv. c. 7, p. 492; Belzoni: Travels in Egypt, i. 306, ed. of 1822; Beechey: Exped. to N.

coast of Africa, p. 109; Chenier: Morocco; Dampier's Voyages; Diodorus Siculos Hist., lib. iii., cap. 28; Ellis: Madagascar, p. 366; Edinb. Cab. Lib., vol. xiv., Arabia, vol. ii; Forbes: Orient. Mem., i. 46; Fennell, J. H., Jour. of Agr., 2d ser. iii. 328; Godard: Disc. et Hist. de Maroc; Glover: Dept. Agr. Rept., 1866; Gerard, W. R., Entomography; Horneman: Africa, p. 59; Hasselquist: Levant, pp. 231, 419; Hooker's Jour. of Bot., i. 113; Herodotus: Melpom. cap. 172; Jackson: Morocco, p. 52; Kirby and Spence: Entomology; Ludolff's Ethiopia; Leviticus, xi. 22; Livingstone's Miss. Trav.; Pliny: Hist. Nat.; Poiret: Insects of Barbary and Numidia; Riley, C. V.: Locusts as Food for Man, Proc. Am. Ass., 1875, Eighth Report of Missouri State Entomologist; Russell: Nat. Hist. of Aleppo, p. 62; Strabonis Geog., lib. xvi; Sparrman: Voyage to the Cape, i. 367; Swainson: Geog. Dist. of An., p. 99; Salt's Abyssinia, p. 172; Shaw: Travels in Barbary, p. 138; etc.

Midges. See Flies.

Moths. Bennett says that on and in the crevices of the Bugong mountains congregate vast multitudes of small moths, which are collected, and after being roasted, are eaten by the aborigines. The body of the moth is large in proportion to the size of the whole insect, and contains a yellowish oil, resembling in taste a sweet nut. The first time this diet is eaten by the native tribes it produces violent vomiting and other debilitating effects, but after a few days the people become accustomed to it, and thrive and fatten exceeding upon it. (Bennett's wanderings in New South Wales. Lond. 1834.)

Plant-lice. A species of Psylla, together with its secretion, found on the leaves of a Bauhinia, is eaten by the Africans, as observed by Livingstone. There is a species in New Holland, found on the leaves of the Eucalyptus, which under the native name, with its secretion of uo-me-la, is, according to Westwood, scraped off the leaves, and eaten by the aborigines as a saccharine dainty.

Spiders. The natives of New Caledonia, as observed by Labillardiere, seek for and eat with avidity large quantities of a spider nearly an inch long, which he calls *Aranea edulis*, and which they roast over the fire. We find no other reference to spiders being used as a food, except by a few persons of depraved taste in civilized communities.

Silk-worms. The Chinese, after they have removed the silk from the cocoons of the silk-worms, send the chrysalis to table, as remarked by Kirby and Spence. In some parts of Madagascar, as Ellis writes, the silk-worms in a chrysalis state are collected in large quantities, cooked and eaten as food, or offered for sale.

Tobacco worms. Among the Pimos Indians, as among the savages of Africa, tobacco worms, which are the caterpillars of *Macrosila carolina*, are gathered and made into soup, or fried until crisp and brown. Vegetables, meal, or seeds are usually added to the composition when made into pottage. Bushels of these worms are gathered for immediate consumption, or to be dried and pounded up for winter stores. (Dept. Ag. Rept. 1870, 427.)

Worms. A worm resembling an earth worm, and which is dug by the Chinese from their rice fields, is conveyed to the various markets and sold to ready purchasers as a delicate article of diet, as is noted by Gray (China, p. 126). In the sea about the Samoan Islands, the Navigator Islands, etc., is found a species of sea-worm called by the natives *palolo*, and which is esteemed a great delicacy, being consumed either cooked or raw. The natives of Australia also eat the cobbera, a large white worm which abounds in immersed wood.

Schweinfurth in his "Africa" says that he has seen the Bongo calmly strip off the disgusting amphistoma worms which literally line the stomachs of all the cattle of this region, and put them into their mouth by handfuls. See *Earth-worm.*

EARTH AS FOOD.

The strange practice of earth-eating seems little understood, although we have accounts of the existence of the earth-eating habits in diverse portions of the globe. As practised in the Southern States, especially among the poorer whites in southern Georgia and Florida, it attracts the attention of the observer, yet it is difficult to obtain data as to the extent of the practice, or the reasons which uphold it. So far as personal inquiries develop, it is claimed to be eaten in considerable quantities as a luxury, rather than from necessity, and the earth used seems to be a species of unctuous clay. Those pointed out as earth-eaters are cadaverous, and of a yellowish complexion. On account of the disinclination to converse, indeed the absolute impossibility of obtaining personal testimony, the writer had to content himself with the statement of those who, probably earth-eaters themselves, were willing to bear testimony only as against others, their neighbors.

The most we know of the practice in its details is obtained from Humboldt, who found in the Otomacs of South America, a tribe of Indians who consume from ¾ to 1¼ lb. of clay daily, and claim from it their principal support. This "earth which the Otomacs eat is an unctuous, almost tasteless clay, true fuller's earth, of a yellowish gray color, in consequence of a slight admixture of oxide of iron. They select it with great care. They distinguish the flavor of one kind of earth from that of another, all kinds of clay not being alike acceptable to their palate. They knead this earth into balls measuring from four to six inches in diameter, and bake them upon a slow fire, until the outer surface assumes a reddish color. Before they are eaten, the balls are again moistened." These Indians are so partial to clay that even in the dry season, where there is an abundance of fish, they still partake of some of their earth-balls, by way of a *bonne bouche* after their regular meals. "It appears to me," says Humboldt, "especially remarkable that the Otomacs should not lose their health by eating so much earth. Has this tribe been habituated for generations to this stimulus?"

In Popayan and many parts of Peru, calcareous earth is sold in the street as an article of food for the Indians, and is eaten with the leaves of the coca. On the coast of Rio de la Hacha, the Guajiros swallow lime alone, without adding any vegetable matter to it. "In the cold regions of Quito, the natives of Tigua eat habitually from choice, and without any injurious consequences, a very fine clay, mixed with quartose sand. This clay suspended in water renders it milky. We find in their huts large vessels filled with this water, which serves as a beverage, and which the Indians call *agua* or *leche de llanka*." We are here reminded that the muddy water of the Missouri and Mississippi is considered palatable and wholesome by the inhabitants on the banks.

In tropical countries, adds Humboldt, it is often found necessary to shut children up in order to prevent their running into the open air to devour earth after recent rains. The Indian women who are engaged in the river Magdalena, in the small village of Banco, in turning earthen pots, continually fill their mouths with large lumps of clay, as Humboldt frequently observed, much to his surprise. Another author, Gilj, also notices the same fact. Individuals of all other tribes, excepting the Ottomacs, lose their health if they yield to this singular propensity for eating clay.

The name of Panama, as asserted by F. L. Oswald, is derived from *panamante*, a substance which the Indians of Central America prepared from a mealy gypsum-powder, found here and there in the Sierra.

Earth is mentioned by Cabeca de Vaca as being eaten by the Ygnazes, and also by another tribe who mix the earth with the fruit of a tree. This in New Mexico or Texas in 1528–36.

The Africans of the lake regions, according to Waitz, prefer earth of dry or bed termite hills. I am told, says our author, that in some of the rivers of the Bight of Biafra, the mud from the bottom is fished up and chewed. The negroes of Guinea, according to De Chauvalon, say that in their own country they habitually eat a certain earth, the flavor of which is most agreeable to them, and which does not occasion them any inconvenience. In the West Indies they endeavor to obtain a substitute, but the *caouac* of these islands deranges their health. Yet although forbidden by the masters, the slaves managed to eat it in the last century, and in 1751 a species of red or yellowish tuff was secretly sold in the public market of Martinique. Tribes of negroes on the Gambia mingle clay with their rice. Goldberry has seen the negroes in the islands of Bunck and Los Idolos eat an earth, of which he had himself eaten, without being incommoded by it, and which was a white and friable steatite.

In Java, La Billardiere saw small reddish cakes of clay sold publicly in the villages for eating. This clay is spread on a plate of iron, and baked, after having been rolled with little cylinders in the form of the bark of cinnamon. In this state it is called *ampo*, and is sold at the public markets. It has a peculiar taste, which is owing to the baking; it is very absorbent, and adheres to the tongue, which it dries. In general it is only the women who eat the *ampo*, either in the time of pregnancy, or in order to grow thin, the absence of plumpness being there regarded as a kind of beauty. The use of this earth is fatal to health; the women lose their appetite imperceptibly, and taste only with relish a very small quantity of food.

La Billardiere also saw earth-eating practised in New Caledonia. The earth here used is a lapis ollaris or steatite, and is eaten in great pieces to appease hunger in times of dearth.

The Tungese of Northern Asia, according to Laxmann, eat a fine clay with reindeer's milk. The Chinese, says Mr. Medhurst, use great quantities of gypsum, which they mix with pulse, in order to form a jelly, of which they are very fond. Williams says: "An emulgent preparation of flour from the dolichos bean, mixed with ground gypsum or tumeric, and a touch of salt, called bean curd, accompanies every meal" in China.

In Europe, even, this practice is not unknown. The luxurious Capuans, according to Duncan (Enc. Brit.), paid a considerable tribute to the Neapolitans for an earth called Leucogæum, which they considered necessary for the preparation of a famous dish called *Alica*. Chandler saw the women and children in Samos chewing pieces of steatite as a luxury. Great use is still made in the East of the bolar and sigillated earths of Lemnos, which are clay mingled with oxide of iron. Kepler partook of the butter-earth, which is eaten with great relish, spread upon bread, by the mill-stone quarriers of

Thuringia. The women of the province of Alentijo, in Spain, acquire a habit of chewing the bucaro earth, and feel a great privation when they cannot indulge this vitiated taste.

In remote Sweden, according to Berzelius and Retzius, hundreds of cart-loads of earth containing infusoria are annually consumed by the country people as bread-meal, more from fancy than from necessity.

In some parts of Finland an infusorial earth is mixed with bread and eaten.

Chronicles and archives often make mention during times of war of the employment of infusorial earth as food, under the indefinite name of mountain meal. Such, for instance, was the case in the Thirty Years' War, at Camin in Pomerania, Muskaw in the Lausitz, and Kleiken in the Dessau territory; and subsequently in 1719 and 1733, at the fortress of Wittenberg.

We have found it impossible to write such a paper as we desired without making it too lengthy, and hence have preferred to give some interesting facts relating to little known foods, with little reference to a strict arrangement, or to a logical sequence. Indeed, as full as these catalogues, they are by no means exhaustive, and but a little research would suffice to add to the list. We have, in fact, in some of our general deductions relied more upon what we have in reserve than what is offered here, and if we have differed in any respect from established statements of authorities, such differences have come from no erratic desire for originality, but from the collation of statements of travelers and original observers.

Mr. WHITAKER. We hear a great deal said about what is healthy and unhealthy by men who go around and get a living by lecturing. I would like to ask if there is such a thing as healthy or unhealthy food, generally, or whether it does not depend more on the wants of the human family than it does upon this theory of what is healthy and unhealthy?

Dr. STURTEVANT. Where you know the population, you can make theories which will apply and be true. If we consider New England or Connecticut as a locality, we can make a rule or a theory which will be true as to the food of the people, because we know the conditions under which they live, we know their habits, and we know what has been found to be healthy and unhealthy. But if we take the population of the world, we shall find that "what is one man's meat is another man's poison." We can lay down no rule which will include the barbarian as well as the civilized man. When I go off in the woods on a trip, I always calculate on two pounds of solid food daily per man, and we get a few eggs, or fish, or something else in addition. While, if you take some other nations, you will find them eating eight, nine, or ten pounds of meat a day right along, as a steady thing, and you find even instances of individuals eating forty or fifty pounds at a sitting; but those are exceptional cases. It would be pretty hard to form any theory which will take in all these cases, but, given the habits and life of a people, and the theories may be true.

Mr. HYDE. I would like to inquire of Prof. BREWER what he knows about the matter of food which has been referred to?

Prof. BREWER. I suppose I have been called upon because of a chance remark I happened to make, that grasshoppers are not so bad an article of food as we might suppose. I happened to be at one time among a tribe of Indians where pounded grasshoppers, baked into cakes, were a common article of diet. I was induced to try them, and I must say they are not so objectionable as they would appear, provided we can leave the prejudices of civilization aside. A great many species of grasshoppers are found in the western States, and they grow larger than they do here. At one time, I had an Indian guide near Lake Mono, and picking up a particularly large grasshopper, about as large as my finger, I said, "There is a good fellow!" The Indian said, "No; legs scratch Indian's stomach." That suggests how they use them. They put them in an iron pot and roast them, so that the legs are brittle, then pound them, and bake them in cakes.

As a matter of fact, some insects,—although I do not recommend them, owing, as I have said, to the prejudices of civilization,—are exceedingly nutritious. The larvæ of certain flies found near Lake Mono and other very salt lakes of the Great Basin are gathered in immense quantities by the Indians, dried, and the hull rubbed off, leaving a grayish white kernel, which is used as food. It is rather greasy, and is preserved with comparative ease. It is known in the Indian language as *kutchavee.* It is said by the Indians to be the most nutritious and satisfactory diet that they have. An Indian will start on a journey from the Great Basin to California, when the snow is from fifteen to thirty feet deep, on his snow-shoes, sleep out in the cold, and stand all the vicissitudes of the weather, and his only food will be that *kutchavee.* It is not unpalatable.

At the World's Fair in Paris in 1855, one of the gold medals was given to an American invention known as "Meat Biscuit," which consisted essentially in taking the juices of beef, mixing them with flour, and drying the mixture. It was supposed that in this way a very concentrated food could be made for armies, and for family uses, in soups, and in a great variety of ways. On one of my trips over the mountains, when it was desirable to have the food in the most concentrated form, I got some of this meat biscuit, but whenever I had any of it served up my men declined to eat it, because they had just been where the Indians ate a great deal of this *kutchavee*, and the taste and smell of this meat biscuit was so nearly like the *kutchavee* that they would not touch it.

That illustrates another thing: that what we eat or do not eat is a matter of prejudice, and no class of men are more prejudiced in that respect than farmers. We are all like children. I will venture to say that there are farmers within the sound of my voice who would not eat an oyster, because of the looks of the thing. That is prejudice.

In the vicinity of Augsburg 200,000 acres are devoted to the raising of snails to be used as food, and I know from experience that they are very palatable. So, from beginning to end, what we eat and do not eat does not depend upon whether the article is healthy or unhealthy, fit or unfit, but upon the prejudices we have formed, often with no foundation. We eat pork. Millions of people in other countries not only do not eat pork but despise every man who does eat it. A man cannot preach the gospel if he eats pork. They will not take religion or anything else from him. The reason we do not eat horse beef to-day is not because horse beef is not fit to eat. There is not a single argument that can be brought against horse beef. Why don't we eat it? It is not because of any scriptural injunction against it, any more than against pork. There was a time when horse beef was eaten to a great extent. How many of you know what hard work it took to stop people from eating horse beef? Horse beef was eaten all over Europe at the time those nations were converted to Christianity, and the sole thing that stopped the eating of horse beef among the people from whom we are descended was the fact that the church came to look upon it, as it was used so much at Pagan festivals, as a relic of Paganism, and the church tried to stop it, and the time came when the eating of horse beef was punishable with death. That was what stopped the eating of horse beef. Nobody contends that horse beef is as good as the beef of cattle, but that it is wholesome, nutritious, and palatable, anybody who has eaten it can testify. It is consumed by tens of thousands of pounds in those countries where beef is too rare to be used, and I believe the time will come when horse beef will be used all over the civilized world. But the change will be very slow, because of the prejudice that exists against it.

This matter of prejudice is an important one because it prevents our eating many things that otherwise would be used as food. Oatmeal was used for horses and not used as food for man for centuries. It is only of late years that oatmeal has been used to any considerable extent as an article of human food. Potatoes had been known one hundred and fifty years before they came into general use. They were not used in France down to the beginning of the present century, I might say. It was not because they were not known to be healthy, nutritious, and cheap, but such was the prejudice against them that even the poor would not eat them. It was not until Parmentier planted potatoes and gave notice that they were raised for the table of the king, and that any one who interfered with them would be punished to the extent of the law, that the people of France began to recognize the value of the potato as an article of food. The same prejudice has existed in some countries in regard to eating Indian corn. I want to see these prejudices done away with, so that when a man has to make a dinner of grasshoppers, as St. John did of locusts and honey, he can do so without suffering from prejudice.

Mr. HUBBARD. I understood Dr. Sturtevant to say that a chemical analysis of the earth that he said was eaten by a certain tribe failed to detect anything that was nutritious. If that is so, it is a singular fact. It would seem that where an article enters so extensively into the diet of a people there must be something nutritious in it. The functions of life would not be carried on unless it did contain some nutritive element, and I suppose chemical analysis would be capable of detecting it, or else have we not got to revise our assumption of what is nutritious or not nutritious, and find what is the nutritive element?

Dr. STURTEVANT. Of course, in giving illustrations of this kind, we give the statements of the people themselves. I do not make the statement that it is what we call a real food, but that it is considered a food by the nations who use it, and that to a certain extent it fills up. It has been suggested that the natives eat other substances, of which they take no account; but the whole thing is left unexplained. There is no question that you must have food, and that earth without any organic matter in it cannot act as food in the sense of furnishing nutriment, and yet it may act as food in the sense of filling up and satisfying hunger, very likely, for the time being.

Mr. HUBBARD. It hardly seems to me that the explanation is sufficient, for, if I understand the case, there are long periods in which that is almost the only or the principal food used.

Dr. STURTEVANT. It is stated that it is the principal food, I said.

Mr. HUBBARD. You consider the authority a little doubtful?

Dr. **Sturtevant.** Everybody must judge as to the authority for himself. I think it requires further investigation to give the whole history.

Prof. **Brewer.** There is one fact that is not taken into account. Savages have been so trained, from generation to generation, that they can live a long while without food. When buffalo is plenty an Indian will eat five, six, or seven meals a day; he will eat an amount that is simply incredible; and then, when times of scarcity come, the amount of starvation he will stand is simply marvelous. I do not mean that he will go entirely without food; he will have a very little now and then.

Dr. **Sturtevant.** It is stated by Marble that the inhabitants of an eastern island drink salt water. If so, it is one of the most startling illustrations of what habit can do for a people that I know of.

Mr. **Cheever.** There is another illustration that seems a little curious to me, at least. You will find a man living near the Crawford House, in New Hampshire, who eats live frogs. He claims that he was cast away upon an island, and was obliged to live upon such food as he could get, and finding frogs the most handy, and having no means of cooking them, he acquired the habit of eating them raw. I had the curiosity to visit him, and actually saw him swallow two live frogs, and according to his own statement they form part of his regular diet.

Mr. **Lyman** of Columbia. It seems to me that some of our scientific friends ought to be able to tell us that many of these things which are taken as food act as deterrents to the destruction of tissue and nerve force, and that is the very reason why they are used. If you can stay the destruction of tissue, as I understand it, by the use of any article, no matter what it is, you stay just so long the hunger and thirst for something to fill the stomach. This nerve tissue is all the time wearing out, burning out, like the wick of a candle, and anything that stops that or deters it prevents it from wearing—diminishes the sensation of hunger. And that is the very law of this clay. It may not be a food of itself, any more than some things which farmers put on their soil, but it combines with something else and produces a beneficial result. I think you will find that thing made plain in one of the last works of Cuvier; I do not remember the volume. I have seen the dirt-eaters of North Carolina, and, if I understand this matter right, there is a certain oil in that clay which, with other things which they eat in small quantities, produces a combination which sustains life. Now, therefore, we ought to investigate this matter a little more closely. It will not do, in a convention like this, to let things go haphazard. We come here for information, and let us have it, if there is anybody here who can give it. That is what I am here to know.

Mr. WETHERELL. In regard to the use of sawdust, to which reference was made, I believe, by the lecturer, I have no doubt that sawdust mixed with fine flour would make very wholesome bread, for the reason that has been given here, that we want distention for the purpose of promoting easy digestion. A fact of this kind occurred. A farmer was bringing some sheep from the other side, and got out of fodder for the sheep, but he had plenty of beef. He chopped the beef and mixed it with sawdust, and fed it to his sheep. The result was that the sheep arrived on this side in very good condition. Not that there was any particular nutrition in the sawdust, but it gave the required distention to the stomach of the animal, and consequently served to promote a healthful condition.

Mr. BAKER. There has been an analysis given of the clay which the clay-eaters use, which shows that it contains an oily substance. In this case the clay came from the clay-eaters themselves. It is believed in this case that the clay was mixed with animal fats before being eaten. There is a considerable conflict of testimony in regard to this matter, which in our present state of scientific knowledge cannot be cleared up, and we shall have to wait for further information.

Mr. CAPEN of Boston. I must acknowledge my indebtedness to the gentlemen who have taken part in this discussion. I am well repaid already for my journey from Boston by what I have heard to-day.

Some fifty years ago, or more, my father said to me one day, "I don't believe people are aware of the value of crow. I think a crow would be good food. If you will kill a young crow we will try it." I did so, and partook of the crow myself, and there was no objection to the food.

Mr. Whitaker. Did you skin it?

Mr. Capen. No, sir, I did not skin it. I think no reason can be given here by anybody why a squab crow is not as good as a squab pigeon. There is no bird that flies that is more careful in the selection of food for its young than the crow. We call it "the carrion crow," but it will never eat carrion if it can get anything else. "Necessity knows no law." We are governed by necessity, taste, or prejudice all through life.

I have been in the habit of eating everything that flies; I have not quite got to eating everything that creeps, although I have a neighbor who prefers snakes to young lamb, and always eats them when he can get them. We have people who eat muskrat and enjoy it. A friend of mine who was a great sportsman brought home a bird one day, and said he, "Capen, you eat everything; I would like to have you try that." It was as fine a looking bird as I ever saw in the market, or anywhere. I carried it home and had it cooked, and made a breakfast the next morning of owl. I have eaten game birds that did not compare with that little owl. I do not know a bird that flies that cannot be eaten when we are in good condition and good appetite.

Mr. Webb. An old gentleman who was giving me an account of some of his expeditions on which he suffered for want of food, said, "The hawk is as good as chicken. A man will eat the crow (or raven, which is the species they have on the plains), but the buzzard and prairie-dog a man will starve to death before he can eat them." He told me of an instance where he was for some ten days with nothing to eat except candles, and a short allowance of them. It is said, I believe, that a person can eat almost anything with impunity when in a starving condition, but I am inclined to think (I never tried it) that he would discard prairie-dog and buzzard.

Adjourned to 2 o'clock.

AFTERNOON SESSION.

The convention reässembled at 2 o'clock, Hon. JAMES A. BILL of Lyme, chairman.

Secretary Gold read a paper on "Butter as an Article of food," by Hon. Richard Goodman, as that gentleman was detained by illness from filling his place in the programme.

BUTTER AS AN ARTICLE OF FOOD.

THE BUTTER FUTURE.

R. GOODMAN, LENOX, MASS.

Not the *better* future in the sense in which that expression is generally used, for notwithstanding the surmises of many illustrious, as well as other persons, that we shall carry on in another state of being avocations similar to those we are engaged in here below, it is to be doubted whether we shall be troubled with dairy occupations hereafter; but if they pursue us they will undoubtedly be confined to the *milky way*. But the *butter* future should be in a lower sense a *better* future not only to those who manufacture and put in the market this almost universal article of diet, but for those who consume it, and while we are contriving how to make good butter with the least trouble and expense and sell it for the best price, we should also make it a cardinal point of consideration how to furnish those who purchase it with an article of uniform good quality, so that their health, appetite, and taste will not be injuriously affected, as now often happens by the irregular, poor, and deleterious article palmed off for butter in the large markets.

Butter has been slow in arriving at a high altitude in quality, and the fine-grained, hard, rich-colored, delicately-flavored kind known as *gilt-edged* is a production in this country of only the past ten or twelve years, and its manufacture arose from the knowledge of a similar quality brought from Europe by the rich and traveled *bon-vivants*, who, if they acquire nothing more useful, return home barnacled with fresh tastes for dress and appetizing delicacies, and give an impetus to the manufacture of luxuries. The origin of butter as a commodity for the table goes back to the Hebrews, and though it has been doubted whether the word in the original usually rendered *butter*—Genesis xviii, 8; Judges v, 25—denoted anything more than sour or curdled milk, it is more likely to have meant the real article, as the Jews in their halcyon days were model farmers and their heathen neighbors acquainted with the manufacture of butter from the milk of sheep and goats, by pouring the latter into a goat-skin bottle, suspending this from the tent-poles and swinging it to and fro with a jerk until the process was completed. All Arab food at the present day considered well prepared swims in butter, and large quantities are swallowed independently in a solid or liquid state. One traveler mentions that those who can afford such luxuries swallow, every morning, a large cupful of butter before breakfast, and even snuff a good quantity up the nostrils. Some tribes welcome a guest by pouring a cup of melted butter on his head, and Parkyns, in his account of life in Abyssinia, says some ladies of that country have their butter daubed nicely on their hair, followed by some scent, but the "great go" among the dandies is to appear in the morning with a huge pat of butter placed on the top of the head, which as it gradually melts in the sun, runs over the hair, down the neck, over the forehead, and often into the eyes, thereby causing much smarting, and if salted, as most of our Yankee butter is, the dandies would be apt to howl and dance a lively jig.

The GREEKS of classical times appear to have made no use of butter as food, though so early as the age of *Hippocrates* they were well enough acquainted with its existence and properties, and the poet, Anaxandrides, says that the Thracians *ate* butter, at which the Grecians were surprised. They displayed much judgment in the selection of their milch cows, milked twice a day—in the morning, immediately after the breaking up of the dawn, and in the evening, about the close of twilight—in wooden pails, narrow at the top and spreading towards the bottom, and the milk was poured into pans, but of their shape we have no information. That they skimmed their milk is evident (whatever they may have done with the cream) from the mention of that thin pellicle which is formed on it only when skimmed, whether scalded or not. "Here, drink this," said Glycera to Menander when he had returned one day in exceeding ill humor from the theatre. "I don't like the wrinkled skin," replied the poet to the lady. "Blow it off," said she, "take what is beneath!"—a counterpart of the story of the modern city lady who refused to take the milk sent in to her on account of the yellow scum which covered the top! Even in southern Europe, at the present time, butter is very sparingly used, olive oil taking its place; and in Italy, Spain, Portugal, and southern France it is sold by apothecaries as a medicinal agent for external application. The Greeks, probably, and the Romans, certainly, used butter as an ointment in their baths, the latter people being taught how to make it by the Germans, but not using it as food. What are now designated as Turkish baths had their originals in the *Thermæ* of the luxurious Roman people, with whom, in the latter days of their great prosperity, bathing had become not only a necessity of daily existence, but, next to their recumbent dinners, an extraordinary luxury, and, from the numerous remains of baths discovered in various points of the empire, we have a distinct idea of their original arrangement, comprising hot, sudatory, tepid, and cold, swimming and shower baths, rubbing and oiling the body. It has been said of the modern English gentleman "that he takes half a day to bathe the whole man," but his Roman predecessors spent a larger part of the twenty-four hours at the *Thermæ*, many of which were fitted up with libraries and gymnasiums, and bathed and were anointed several times, and *butter* must have commanded a good price if used as the general ointment. Pliny, the celebrated Roman lawyer, in one of his letters to the Emperor, speaks of his recovery to health by the process of rubbing and anointing; and the story is told of the Emperor Hadrian, seeing a veteran soldier one day rubbing himself against the marble at the public baths, asked him why he did so. The veteran answered, "I have no slave to rub me," whereupon he was given two slaves and sufficient to maintain them. Another day several old men rubbed themselves against the wall in the Emperor's presence, hoping for similar good fortune, when the shrewd Hadrian, perceiving their object, directed them to rub one another!

When Julius Cæsar invaded England he found that the inhabitants had abundance of milk, from which they made butter, but could not make cheese till they were taught that art by their conquerors. Among modern nations, in addition to Great Britain, where the consumption is much greater than the farmers can supply, Holland is the most celebrated for the quantity and quality manufactured, but nowhere out of Paris, until quite recently, could the true *gourmand* find those golden pats flowing with flavor which have incited our breeders of fine cattle to a spirit of emulation, and a few private dairies in the country are furnishing to those willing to pay the price an article almost, if not quite, equal to the sample. The FRENCH have a certain *gout* and refinement in matters sensual not common to the English or Teutonic races, and their tables are not so richly loaded "that neither purse of the host nor stomach of the guest will allow them to repeat the exercise very often," but they find and give enjoyment in lively and agreeable entertainments where the charm lies in the superlative excellence of the viands rather than in their numberless variety, and in the social and conversational exhibits not handicapped by helpless indigestion. At the entertainments of the rich middle classes in England and this country the reverse is the case, and the host thinks it imperious to stuff his guests as the cook does his turkey, and in the greater quantity the quality is overlooked and the finer tastes smothered if not destroyed. One eats more bad butter at these feasts of the "new rich," where all the vegetables and meats are drenched with it, than he would in a twelvemonth at his own table, and if he pumps his host he will find that the few pats in sight are bought for show, while the large amount used is called "cooking" butter, and is purchased at the low price such inferior article brings.

In this country the palm for the best table butter during the last thirty or forty years must be awarded to Pennsylvania and to those manufacturers in the vicinity of Philadelphia who have furnished that city with such a superior article that it was, and perhaps is, no uncommon sight to see an habitué of the best hotel cover his buckwheat cakes with at least a quarter of a pound of it at a time. The *Darlingtons*, who, father and son and father-in-law, have for several generations maintained such a reputation as to obtain from 75 cents to $1.25 a pound for their butter, which is also sent largely to New York, have not been dependent on any especial breed of cows, but have owed their success in part to the rich pastures of their farm; but mainly to the especial neatness and care with which all the processes are carried on, from the milking of their hundred cows to the final stamping of the pats, and to the coloring and flavoring which they give to their products.

This coloring, to a Philadelphian and to the New Yorker, is an essential element, and a great deal of poor butter is eaten thus disguised, and a false taste created, which makes, in many instances, a much better article to be spurned because its natural delicate straw color has not been spoiled by artificial infusions. Following after the "Darlington" have appeared "Echo Farm," "Pine Cliff," "Yokun Farm," "Burnet's," and other brands, which have a name in the New York and Boston markets like those which designate wines or beer, and command an extraordinary price, and are absorbed by the first-class hotels, clubs, and rich private families.

There is no doubt that good butter owes often much of its flavor to what the cows feed on, like that of Epping and Cambridge in England, the cows which produce it feeding, during summer, in the shrubby pastures of Epping Forest, and the leaves of the trees and numerous wild plants which there abound are supposed to improve the flavor of the butter, just as the forage of the counties of Chester and Lancaster in Pennsylvania is considered to be the richest in the State, and to impart to the butter made from it that aroma which is really owing in large part to the manipulations of the makers. The butter of the mountains has always and everywhere, when properly made, been of excellent quality, and no sweeter pastures are to be found than those which cover the New England hills.

Ireland, said an acute observer, would produce the finest butter in the Empire were it not for the intolerably filthy state of their cows, and the want of cleanliness in their dairies, and for the same reasons added to a want of "know how to make good butter" is the reason why more than half the product of the dairies in this country is unfit to be eaten. The committees of the two leading societies in Berkshire reported last fall that one-third of the specimens of butter sent in for *premiums* were not fit for table use, and if such a proportion especially prepared was in that condition, how much larger must be the proportionate amount sent to market! Two or three years ago I called in Boston, on a man who advertised a coloring salt and butter worker, and found his business was to work over and resalt and flavor tubs of the article sent to him by the consignees. Emptying part of a tub just received on a large table, he rolled it out as flat and as thin as a pancake, and then began to pick out the specks which varied from small tacks and hairs of the buffalo or other animal, to hoopskirts in small pieces; and when the process was over, re-rolled and repeated it, and finally salted and colored and flavored the mass with his preparation, and repacked it—a new article to the eye and use, and the consignee was able to add several cents more a pound to its price. *Ex uno disce omnes:* from these samples one could form an idea how much bad butter is made, and assent to the reasonable adjurations and unwholesome exclamations which resound from all ordinary hotels, boarding houses, and restaurants, and even from private families, whose heads find it difficult even in the markets of large cities to get a good article at a fair price, or what they consider such. The future of good butter requires a two-fold education, one on the part of the manufacturer, and the other of the consumer. If the name of the bad makers is legion, that of those who have not taste enough to appreciate the best article so as to be willing to pay a remunerative price for it is multitude! Even the wealthy people who buy a few pounds of the fancy brands for their private table cheat Peter to pay Paul, by allowing their grocers to send a very inferior article to cook with, and thus they and their families get into their stomachs a great quantity of grease in its worst state, pluming themselves all the time on their penurious wisdom in paying a big price for a few pats for their bread and butter.

There is a vast amount of brains and wise teachings expended by men of talent on the "How to make good butter," through the books, papers, and meetings, but the class to be instructed is too large, and seed falls in too large measure upon barren ground. The implements and processes mixed with brains which go to making *uniformly* good butter, from the best cows, good feeding, clean milking and stabling, setting, skimming, churning, packing, etc., are not to be acquired and properly carried out by every person, any more than good bread can be uniformly made by every housekeeper, and we can imagine in cities the confusion, disgust, and disappointment which would ensue if, instead of the regular bakers, the various households dependent upon such production for their support should send to the public market the baked and unbaked, overdone and slack done, hard and doughy, saleratused and unsaleratused, dried and clammy outcomes of their myriads of ovens. That is about the condition of the butter market of the present day, as it was somewhat of the cheese market before manufactories of that article were established, although it was easier to make a uniform quality of cheese by hand than of butter.

The general mass of butter of the future will be made by *Creameries*, for over them will be an intelligent direction which can absorb the teachings of the specialists who are devoting so much time to the right making of butter, which can employ the capital necessary to carry out the constant improvements in the processes, and more than all, which can, by rigid supervision over the area from whence comes the milk and cream, compel cleanliness in the crude product, and discard all emanating from cows in filthy stables, or milked by uncleanly hands on dunghills, and in festering barn yards. Butter when produced from these establishments, of continuous good quality, will soon acquire a name and reputation, and the public taste for good butter will be formed, and consumers will be willing to pay a fair price for an article in which they have confidence, and the individuals who make regularly bad butter will find it more profitable to turn their attention to some pursuit requiring less ability, and which they can carry on without much regard to scrupulous cleanliness.

Creameries cannot and will not be able to make and put on the market that superior article which has obtained the appellation of "gilt-edged," which must continue to be the special product of capitalists who *con amore* provide cows of especial breeding, pastures of utmost richness, and free from foul seeding; winter food of high graining, dairy utensils of tiles, porcelain, and glass; dairy men and maids of irreproachable purity, and have all the processes carried out in the same "regardless of expense" manner, knowing that their "brand" will ensure from the rich customers a price which will repay for all this outlay. But the creameries will furnish butter much superior to the present average, and be able to sell it at a price which is within the means of all those who are willing to purchase good articles for their table, and are not among the "foolish virgins," or others who starve the belly to feed the back, and prefer display to substantial food.

The same public interest which is now displayed in compelling the furnishing of pure milk will soon be turned to butter, and the medical authorities, the mothers of infants, and the heads of families will realize how much ill health and discomfort is owing to the "cooking" butter which they use in profusion, and to the strongly salted article from the tub which is put on the table, and will turn their attention to the product of the creameries, which is furnished fresh every week, and which can be relied on as healthful, tasteful, and in all respects satisfactory.

The only substitute I can think of for the creameries, and likely to oust them from the sphere of usefulness they are growing into, is the *butter tree*, which some of our enterprising farmers, when tired of cultivating tobacco and sugar beets, may import from the interior of Africa, where it was discovered by Mungo Park. This remarkable plant yields from its kernels, by pressure, a white, firm, rich butter, which even in that climate *will keep well for a year without salt!* There are the large tropical trees such as the Phulwara tree of India, the Illupic of Coromandel, and the Madhuca of Bengal, possessing similar qualities, worthy of propagation at the botanic garden of the Agricultural College, and of distribution among the farmers, which may in time subvert all our cow-honored institutions, and save the turmoil and anxiety which overwhelm us in making and furnishing *good butter.*

The Chairman introduced Prof. **Peter Collier**, of the Agricultural Department at Washington.

SORGHUM AND CORN AS SUGAR-PRODUCING PLANTS.

BY PROF. COLLIER.

Mr. Chairman and Ladies and Gentlemen:

I am very happily disappointed in being able to meet with you. Not having advised the Secretary at what hour I could be present at the meeting, I supposed I was ruled out, and counted on having a good quiet time as a listener. But I feel that I have a matter to bring before you of as great practical importance as any that can be considered.

Those of you who have seen that admirable representation by Mr. Raymond of "Col. Mulberry Sellers," in the "Gilded Age," will remember how he proposed to pile up a colossal fortune by the sale of eye-wash to the teeming millions of Asia, and finally concluded with the assertion that there were "millions in it." Now, I am going to speak almost entirely by millions, and yet I think I appreciate, as I trust none of you do, how much a million dollars is; indeed, how much five dollars is. But I shall deal in millions, and I am delighted to be here before you, older and wiser men, that you may yourselves take the facts which I have, and concerning which I am only solicitous (I am prepared to defend *them*), and say whether I am astray one whit in the conclusions which I draw from those facts.

Now, in regard to the magnitude of the question, I will say that few of us can possibly realize it. I am going to speak about the production of sugar at home, and from material that has hitherto been regarded as refuse. I think, if anything characterizes this age, as distinguished from others, it is the utilization of refuse material, waste products, and we all of us know, when we consider for a little how abundant those are upon the farm, how important it is to utilize these materials as far as we are able.

Now, this waste, I say, is almost incredible in the matter of sugar. We imported last year $109,000,000 worth of sugar, counting the duties and the original cost, and of course they both come out of the pocket of the consumer. We have imported, since 1848, when gold was discovered in California, an amount of sugar which has taken for its payment the entire product of all our gold and silver mines of the west—$1,800,000,000. Imagine what might be our present condition financially if we could have saved all of this money! We hear sometimes of the bonanzas of the west, of the Comstock lode, and of Leadville, but all those bonanzas, not only of the past two or three, but of the past thirty years, large or small, have sent abroad their products to provide us with sugar. We consume, on an average, every man, woman, and child in the United States, between thirty-five and forty pounds of sugar annually, and we would consume, were it only half as expensive, twice as much, because, as you all know, it is a healthful, nutritious, and, moreover, a delicious food. But all of this time we have been throwing away a material which would have furnished us, had we availed ourselves of it, with a thousand million dollars worth of sugar annually. We could fill the markets of the world with the sugar which we are annually throwing away unutilized.

I have heard, since I left Washington, that there is some talk of abolishing the Department of Agriculture. It seems to me that if the Department of Agriculture should be effective in helping the solution of this problem, it would have paid for itself for a thousand years to come, if it should do nothing else, even with a more liberal appropriation than it has. The Commissioner of Agriculture has been hooted at by some as being insane on this matter of sugar. I am crazy the same way,—have the craze worse than he, I think,—simply because I have had more direct personal control of the experiments, while he has been cognizant only of their general result. I confidently predict that within five years we shall produce all the sugar we need; within ten years, we shall export more than we have ever imported. These are the conclusions I have drawn. That they are immense in their importance you will admit. I trust you will follow me carefully through, and see if the results that I have secured in my laboratory work, and some few experiments in the field, bear out and justify these conclusions.

I have been working chiefly with sorghum, but have made some experiments with corn-stalks, and I will speak first in regard to my experiments with sorghum, and then go into some little detail about the other.

The sorghum is a plant, I doubt not, known to all or most of you. It resembles our broom corn, which is another member of the same family, a sorghum, but the sugar sorghums were imported some twenty-five or thirty years ago from China and from the coast of Africa, and they are now known as the Chinese and the African sorghums. Although it is almost impossible to-day to get any seed of the varieties which were imported then—they hybridize so rapidly—yet we have some fifteen or twenty, at least, of different well-established varieties, as is the case with our Indian corn. Four kinds of sorghum were planted at the department last spring, the 15th of May, and an examination of those plants was made continuously during the season. Every three or four days a selected stalk was taken from the row of each, and a complete analysis was made of it. The butt of the stalk, and the top, the upper and lower halves divided, approximately, into equal weights, for the purpose of learning what we could in regard to the development of sugar in these plants. The examination began when the seed head first appeared, and was continued until the 29th of October—indeed, until about the 5th of November. On the 23d of October we had a heavy freeze in Washington, which gave us about half an inch of ice, and an examination was made subsequent to that to learn the effect of the freeze upon the sugar that the stalks contained, and of the effect of the subsequent thaw which ensued.

Now, I will give what we found true with one variety, and that was true of every other one. At the first examination, we found that the juice contained from four to six per cent. of uncrystallizable sugar, and from one to three per cent. of crystallizable sugar. Now, I would say that the value of the juice, whether of sugar-cane, or beets, or sorghum, so far as the production of sugar is concerned, depends upon two things. First, on the amount of sugar, other things being equal, which is present; obviously, the more sugar in the juice the more you can get, other things being equal; but inversely upon the amount of uncrystallizable sugar which is present, because that will prevent your getting a large proportion of the sugar which may be present that is true crystallizable sugar. Now, the results, I think, will be intelligible. We found that at first there was from four to six per cent. of uncrystallizable sugar, and from two to four per cent. of crystallizable sugar. Now, there is no known practicable method by which any one can obtain from a ton of such juice a pound of sugar. We may prepare, and we have prepared, excellent syrups from such juice, but crystallized sugar, with our present knowledge, is an impossibility. But we found, upon subsequent examinations, that the uncrystallizable sugar diminished from four to five or six per cent. until it came down to three, to two and a half, to one, and in one case to six-tenths of one per cent., whereas the crystallizable sugar increased until it became ten, eleven, twelve, thirteen, fourteen, and in one case seventeen per cent. of the juice; and all of those different kinds we found, when in their best condition, to contain about one per cent. of uncrystallizable sugar, and about fourteen or fifteen per cent. of crystallizable sugar. Now, a juice like that is quite as good as the average of the best Louisiana sugar-canes. As evidence of that we sent to Louisiana (because it seemed possible there might be some defect in our processes—and I am not giving you the result of one or a dozen experiments—in the aggregate we made over two hundred and fifty separate determinations, and what I state is the general result of them all)—we sent to Louisiana and received from the president of the Louisiana Sugar Planters' Association about twenty stalks of three kinds of their best sugar-cane. They reached Washington in excellent condition. They were treated precisely as the sorghums had been treated, with the same reagents, with the same methods, and the results showed that they were not one whit better than those sorghums were, in their best condition. I have a chart upon which these facts are given, but I can give them sufficiently near for practical purposes. The results will be published in full within a couple of months, and distributed about the country. I will say that the average of the best sugar beets which we examined—the best five out of seventy-one which came from all parts of the country—was 12.46 per cent. of sugar in the juice; less, you see, than of those sorghums.

Now these sorghums can be grown wherever corn can be grown. Before the convention of the National Patrons of Industry, at Canandaigua, I appealed to the sorghum growers there, and thirty States were represented at that convention, and they all said that it can be grown with no more expense than an equal area of corn.

I made a few experiments to determine whether this sugar could be obtained which was present in the juice, and I found that, taking an average of the nine best syrups which I made by forty different experiments, using up in the aggregate over twenty-three tons of stalks of the sorghum—and I examined in every case the juice which I converted into syrup, and then examined the syrups after I had obtained them, that is, determined the amount of crystallizable sugar—I found that, taking the best nine of the syrups I made, I had obtained in the syrup 92.7 per cent. of the sugar which was present in the juice. That is, it had practically suffered no inversion (by inversion I mean the conversion of the crystallizable sugar into the uncrystallizable condition). But I also examined the nine worst syrups I made. I mean by that, those which never would have yielded any sugar, because the amount of uncrystallizable sugar was so large. But I could determine by other means the amount of crystallizable sugar which was there, and I found that in the nine worst syrups which I had, I secured over ninety per cent. of the sugar which was present in the juice.

Now these experiments are conclusive upon this point, that any of you, or any one in the country, by following the method that I did, may obtain in the syrup all the sugar which is present in the juice, or practically so. And I will say here, that I had hoped to meet Prof. Goessman, and learn what his method was by which he, according to the results which he has published, inverted over 28.6 per cent. of the sugar which was in the juice; and the inversion of this crystallizable sugar, that is, its conversion into uncrystallizable sugar, made so much uncrystallizable sugar in his syrup that he could not crystallize out any sugar, and therefore he decided that it was of no account as a sugar-producing plant.

Now in regard to the character of these best syrups that I made, I found that every one of them very speedily became semi-solid from the formation of crystals of sugar throughout the mass. They deported themselves precisely as syrups made from sugar cane would have done. It was so thick that it could be shoveled into a cart and put into a centrifugal machine, as I would have done if I had had one; but not having one, it was put into a grain bag, in which way I succeeded in pressing out the molasses which was present, and in obtaining a sugar which could be sold by the hundred thousand tons in any market in christendom to any refiner, as good as the average best ten per cent. of our Cuba or Louisiana Muscovado sugars, open pan sugars; and yet the apparatus I had (and it would have sufficed to have worked up a crop of twenty or twenty-five acres,) did not cost over $150. Mr. Aiken of South Carolina, to whom I applied as to the expense of his apparatus, said that $100 was sufficient. $100 then, according to his statement, is sufficient to enable any one to prepare a product which is as marketable as bullion. I will say that my brother-in-law, a farmer in central New York, this year tried the experiment with a few acres, and succeeded in making an excellent syrup, which he sold to his neighbors at fifty cents a gallon, until it was sold out. Some of it found its way to New York, and he had an order for 500 barrels at fifty cents a gallon, which he could not fill. I have no doubt whatever that any one would have said that it was rightly worth it, if any syrup in the market was worth fifty cents a gallon. A gentleman at Crystal Lake, in

Maryland, knowing what I had done last year, not this, thought it was worth while to try it on a large scale. He got a vacuum pan and worked up the syrup from an inferior material, and made forty-two thousand pounds of sugar, a sample of which I have here, which he sold at ten cents a pound as a raw sugar. He was satisfied, as I understand, with his experiment, and is going into it again.

Now it seems to me that these facts are worth considering. I succeeded in making from every one of those sorghums which I could control at the rate of over a ton of sugar to the acre. The average product of Louisiana sugar cane, according to an editorial in the New Orleans *Times* of November 21st, sent me, was 1,350 pounds of sugar to the acre. I made at the rate of over a ton of sugar to the acre. I have not a shadow of doubt that from a hundred acres of good corn land one hundred tons of excellent sugar can be produced. More than that, with certain varieties, which cannot be grown here in Connecticut, however, to maturity, I have no doubt whatever that two tons of sugar can be produced to the acre. From a variety of sorghum which grows very large I obtained a crop which was equal to three tons to the acre.

The main point in regard to the whole matter, practically, was the time when the cane should be cut and worked up. That I found to differ very widely as to the period, but as to the evidences on the part of the plant it was identical. It was when the plant was thoroughly matured, gave every evidence of being ripe; when the lower blades were dead; when the seed was hard and dry, thoroughly ripe; when offshoots had sprung from the upper joints of the stalk. Whenever the stalks showed those indications, no matter what the variety was, I found that the percentage of sugar in the juice was at its maximum. I found, moreover, that every one of them maintained that condition when once attained until this frost or freeze of October 23d put an end to them. Some of them had been two months in that condition, giving a time nearly twice as long as they have in Louisiana to work up their cane. So that in this latitude there is no doubt that you would have a period equally long for working up the crop that they have in Louisiana from the slow growing of the cane, which requires nine months—indeed, requires eleven or twelve months for its maturity. It never matures in Louisiana. Probably there was never a cane ripened in the State. Not one planter out of a hundred, probably, has ever seen a perfectly ripened sugar cane, unless it was imported from some tropical country or raised in the hot house.

One other point in regard to this. I have said that the amount of our importations of sugar aggregated last year $109,000,000. We produce about 13 per cent. of the sugar we consume, and that is produced in Louisiana. 87 per cent. is imported. It chiefly comes from Cuba, and if moral considerations were of any account here in discussing this question, our money goes to support an institution that we, thank God! have done away with—slavery. Then there is another consideration, to illustrate which I will tell you a little story. I have a little girl at home who was delighted when in the afternoon I would bring a little package of brown sugar for her, not very presentable, perhaps; and one day, when she was eating it in company with the children of some of the families in the neighborhood, they said, "We have white sugar in our houses." "But," said my little girl, "my papa made this.". Now, it seems to me that that point would apply to us as a nation; that if it is possible for us to produce sugar economically, it would be a satisfaction to us to feel that we were self-supporting, that we were living within ourselves. I remember an old coin that was struck long before my time, but one of which came down to me, which had the legend upon it, "not one cent for tribute, millions for defense." It seems to me that is a good point.

We are paying tribute to other countries, an enormous tribute, at a rate greater than the aggregate gold production of the world, which was estimated last year at $100,000,000. We pay more to the sugar growers of foreign countries than the aggregate production of gold in the world, and yet, as I say, we are now throwing away ten times that sum every year.

Now, a few experiments in regard to cornstalks may be of value. But I will say first in regard to sorghum, that I think that is the most profitable as a sugar-producing plant, and I should advise any one who wishes to go into sugar to plant sorghum rather than corn. But we have rather insisted upon cornstalks because it seems like eating one's cake and having it at the same time, and we thought that many farmers might go into this enterprise who would not wish to give up a few acres with the possibility of failure, whereas if they failed in the attempt to make sugar from their cornstalks, it would not be of so much account. Now, our acreage of corn is so great that, without reaching even the results which we have secured in our trial, nine per cent. of the acreage at present in corn in Illinois will produce all the sugar we import. The whole acreage of Illinois produces $75,000,000 worth of corn. Nine per cent. of that will produce $109,000,000 worth of sugar.

I certainly have faith to believe that there are thousands of Illinois farmers who would do better than I would, practically, and I would undertake, if I could have absolute control of nine per cent. of that corn land, to produce that amount of sugar every year; and the same is true of the other States.

I do remember that of all the land we have under cultivation, including that in hay, cotton, cereals, and root crops in the United States, 38 per cent. is in corn; so, as I say, we cannot touch this question without going into millions. The aggregate production of corn is four hundred and eighty millions and a trifle of some six hundred thousand dollars, if we consider that a trifle. If we should give up one and a half per cent. of that corn land to the cultivation of sorghum, we might produce $109,000,000 worth of sugar. That is, we can produce from one-tenth the ground a crop forty per cent. more valuable than the produce of the whole; and the universal testimony is that it costs no more to raise a crop of sorghum than it does to raise a crop of corn.

But here is another point, before we go into the matter of corn. I was examining the other day the returns from the country in regard to the production of cereals, and I must say that I was astounded at the exhibit. I found, taking the western States, from Ohio west, ten States reported in 1862, and all of New England, the Middle States, New York, New Jersey, Delaware, Maryland, Virginia—eleven of them—I found that between 1862 and 1877, a period of only fifteen years, the corn crop—and remember that 38 per cent. of our cultivated land is in corn—the corn crop had fallen off in those western States over twenty per cent. in its acreage yield, and in those States which we may regard as older western States, like Illinois, it had fallen off 27½ per cent. in its acreage yield in fifteen years. It was no local blight or early frost which produced this result; it was continental. I took all these States and grouped them, and the result was a falling off in fifteen years of over 20 per cent., and of wheat, the next staple cereal in value, the yield had fallen off 16$\frac{9}{10}$ per cent. in fifteen years. On the other hand, taking our eastern States during the same period, the acreage yield of the corn crop had fallen off but nine-tenths of one per cent.; had practically maintained itself. The acreage yield of wheat had fallen off four and a half per cent. only, as compared with sixteen and nine-tenths per cent. in the west. More than that, I found that the average yield per acre in the east is to-day very much in excess of what it is in the west. On lands which have been farmed one hundred years longer than those of the west we are to-day raising on each acre more corn and more wheat than they do in the west. I do not mean to say that we raise it so cheaply, bushel for bushel, but in regard to that matter no one will believe, perhaps it seems almost incredible, that even fifteen years ago they made twenty per cent. on the corn which they raised; that every hundred dollars worth of corn enabled them to put twenty dollars in their pockets. I know the question was discussed up in New Hampshire, and they almost decided that farming did not pay one per cent. on the investment. I hope it would make a better showing than that, but it is hardly probable that it pays in the matter of corn twenty per cent. a year, and yet it has fallen off in fifteen years at the west more than the entire profits in its production; and we can easily calculate how soon the time will come when it will be impossible for them to raise corn at the present prices, and when they must have recourse to the same things which we came to twenty-five years ago, which England has come to until it has carried its agriculture in that respect to the utmost verge, and so eminent an authority as Mr. Lawes says, in his address to the farmers (I do not quote his exact language), that they have raised the very last bushel of cereals that they can raise profitably. They may possibly raise more by putting on more fertilizers, but the fertilizers will cost them all that the additional crop is worth ; and consequently to-day we have a parliamentary committee coming over here to see if they cannot learn something from our methods of agriculture that will be of advantage to the English farmer. But, as I say, we are drifting into the same condition of things. Here it is a question which I am not discussing, as to whether it will pay to use fertilizers, but we can see the effect of having used them, for upon our lands farmed for a century longer than those of the west, we are now producing more to the acre than the fertile lands of the west. Ultimately the time must come when the farmers of the west will have to put on fertilizers or adopt some other method of enriching their lands, which are so rapidly becoming impoverished. England, with a territory but little larger than the State of New York, imports annually, or did when I received the last statistics, and they were official from the London Board of Trade, $20,000,000 worth of animal fertilizers or fertilizing material from outside her borders, not taking into consideration the acres of wheat that go into her bread stuffs and are consumed there, and go to enrich her soil by the refuse which the consumption of that crop leaves. The other day Prof. Ledoux of North Carolina, said that last year they had used $2,000,000 worth of fertilizers; in Georgia they had used $3,000,000 worth. That is the recourse to which we have been driven to maintain the fertility of our lands. Now, this matter of the exhaustion of the soil becomes important. I have calculated the manurial matter in the corn crop of our country alone, and, taking an average on the analyses of twenty-eight different kinds of corn grown all over the country, I find that the average manurial matter or ash in these corns is 1.63 per cent. Not a very large amount,—about a pound to the bushel; but we are dealing in millions now. Our corn crop is, approximately, fourteen hundred millions of bushels annually, so that one and sixty-three hundredths per cent. goes into the hundreds of thousands of tons of manurial matter in the corn itself; I have no reference to the stalks. This ash is composed, unfortunately, of two constituents, which are the most expensive in those fertilizers which we buy—phosphoric acid and potash—containing about 46 per cent. of one and about 34 per cent. of the other. I calculated that, at the price which we are glad to pay for those two constituents when we buy fertilizers, the phosphoric acid and the potash in the corn crop of the United States would amount to the amazing sum of $99,000,000, and the entire value of the corn crop is only $460,000,000. Fortunately the phosphoric acid and the potash are about the only things of value, except nitrogen, but the phosphoric acid and the potash come from the soil, and the destruction of these impoverishes the soil, and it is with these that we have chiefly to do now. The entire corn crop aggregates $480,000,000, and the phosphoric acid and the potash alone, if bought at the prices we are glad to pay when we get our money's worth and are not swindled in commercial fertilizers, is worth over 20 per cent. of the entire value of the corn crop. When the time comes that to maintain the fertility of the western lands it is necessary to put upon them these constituents, as we are doing here now, you can see to what an extent it will diminish the profits of the culture of corn in the west.

Now in regard to this matter of sugar. Sugar, as you are aware, is a product of atmospheric constituents. We might export, if there was a demand for it anywhere, $1,000,000,000 worth of sugar every year, and our lands would not deteriorate one whit. On the other hand, there is no reason why they should not increase in fertility. Whereas it is quite the reverse, as we have seen, when we transport the cereals from the land.

Now in regard to cornstalks. I have examined quite a number of cornstalks at different periods of their growth. I started with some prejudices in regard to the matter, and consequently I supposed that the only time to examine them was when the ears were green, not hard, and I made only these experiments last year. The experiments resulted in making an excellent sugar readily. I had made examinations and analyses of the green corn to see how profitable it would be for feeding, hoping that the stalks, after the sugar had been extracted, might be profitable for feeding purposes. It is unnecessary, however, to consider even that, because we may allow the corn to ripen. And also we have enormous areas of corn grown for the purpose of canning. One gentleman in Baltimore had two thousand five hundred acres this year, all of which he canned at the rate of seventy-five acres a day, putting up seventy-five thousand cans every day, the cornstalks remaining being treated as refuse. I have had a talk with him in regard to a project for utilizing them another year in the manufacture of sugar. I have no shadow of doubt that an amount of sugar could be obtained from those stalks greater in value than the corn which he obtained from them, and he is going to try the experiment. I understand that in Maine last year they canned a million and half dollars' worth of corn. Now, there was a million and a half dollars' worth of sugar in the stalks, probably not wasted as in Maryland, which might have been taken from the stalks, as I shall show a little further on, and we should have had, as in another case, our cake and eaten it too. Our stalks would have been just as valuable for fodder after we had obtained this sugar as before. Now I see a smile going round among the audience. I have been around among three or four audiences of farmers, anxious, as the Irishman said, that some one would "tread on the tail of my coat." I wish any one would trip me in this matter if they can. I am speaking deliberately.

QUESTION. Isn't there any nourishment in that sugar?

Prof. COLLIER. I will explain in one moment. Indeed there is—the best in the world, but it will not do to feed on nightingales' tongues if beef will do as well. Perhaps I may as well advert to that matter now while it is fresh in your minds. I have here some analyses of two different kinds of sorghums and of cornstalks. I will tell you what I did with them. I selected a half dozen stalks of each kind, and then, that there might not be any mistake about it, that I might get a fair average in each experiment, I slit them longitudinally, and I took half of them and put them through a mill precisely as though I was making sugar from the juice; the other half I dried thoroughly without putting them through the mill; and the pressed stalks I dried thoroughly. I also took the leaves from each of those stalks and dried them all. Now, I find that the dried pressed stalks are of equal nutritive value with the dried unpressed stalks, pound for pound. They have not absolutely the same composition, but I will read those things which are by common consent regarded as nutritious—the starchy compounds, the sugar, the albuminoids, and the nitrogenous compounds. I will read first the percentage of sugar in the unpressed and the percentage of sugar in the pressed.

In one variety of sorghum there was 34.73 per cent. in the unpressed; in the pressed, 19.36—more than half as much, you see, of sugar. It ought not to have been there; if I had had a good mill it would not have been there. In the other variety there was 38.14 in the unpressed, 21.77 in the pressed—over 60 per cent. as much. In the cornstalks, 26.001 in the unpressed, 10.008 in the pressed.

Now of the starchy compounds there was in the unpressed, 20.34; in the pressed, 31.46—50 per cent., you see, and over, more starchy compounds in the pressed corn than there was in the unpressed, absolutely dry, water free. This was not sweet corn, but common field corn.

QUESTION. You have not got as much of it.

Prof. COLLIER. Of course. That is just the point. Unpressed, 20.34; pressed, 31.46; unpressed, 17.67; pressed, 26.23; unpressed, 22.44; pressed, 23.16. That is, there is a greater per cent. of the starch compounds in the pressed than in the unpressed. Nitrogenous matter—sorghum, unpressed, 4.95; pressed, 3.96; other sorghums, unpressed, 4.81; pressed, 3.87. Cornstalks, unpressed, 6.90; pressed, 6.04.

Now it is questionable, without calculation, as to which of these would be of the most nutritive value, weight for weight. The other day there was opened at Billerica one of those *silos*, where the French process for the preservation of green fodder had been experimented upon, and the last account, if it did not show a complete and satisfactory experiment, seemed to leave no reason to doubt, I think, that it will ultimately be so. But what was done in this case? A crop of corn was raised, it was cut up in the mill, it was packed in the *silo*, and it is now being fed. After the stalks have gone through the mill, and you have obtained all the sugar possible from them, they are in a better mechanical condition, better adapted to go into the *silo*, than they would be if simply cut up. They are in such a condition that I have no doubt (although I have not analyzed the green corn, but propose to do it another year) that their nutritive value is equal to that of the ordinary fodder corn, and we may in this way utilize this product. That is, we have it as refuse material, having obtained all the sugar we can from the crop.

Now one other point, on which I have but one experiment. I should have tried others if I had not been convinced beforehand that it was going to fail. The result, however, was so surprising to me that I confess I have no longer any opinion in regard to the matter that I am not ready to lay aside within an hour. I planted two rows of ordinary field corn, white corn, of which millions of acres are grown throughout the south and west. They were all coarse growing, white dent corns. As evidence of that I would say that the stalks average over a pound and a half apiece. You see they were very coarse stalks. After the crop had ripened, and the husks were thoroughly dead and dry, and the corn could be shelled readily, so that I had a bright, hard, merchantable corn, and I obtained a crop at the rate of 69 bushels of shelled corn to the acre, 56 pounds to the bushel,—when we were cutting up the stalks to clear up the field, they seemed so juicy and fresh that I thought it worth while to try them for sugar.

The next day they were put through the mill, and the best juice, in its contents of sugar, that I obtained from any corn stalks, sweet corn or anything else, was that juice which was obtained from those stalks, after a large crop of corn had been taken from them. I have no doubt whatever that this is not an exceptional case, and yet it is in the face of most of the testimony in regard to the matter. I have heard of experiments made as far back as 1840 or '41, where the stripping of the incipient ears and pulling off the tassels was advised to prevent the formation of ears; but here I had a very large yield, not unprecedented, but still a large yield, more than twice the average in New England, 69 bushels of shelled corn to the acre, and yet I had a juice that was better than any of the other cornstalk juices that I examined, and which gave me sugar at the rate of about a thousand pounds to the acre. Remember that the sugar cane of Louisiana gives 1350 pounds, on the average, though I doubt whether that is high enough, but from that to 1800 pounds; and yet two and a half tons of sugar have been produced from an acre of sugar cane.

Now it seems to me that these experiments are well worth following out. I have no doubt whatever that we may in this way utilize our cornstalks. I have no doubt that even where the corn is used for canning, if the stalks were allowed to stand long enough in the field to mature, they would then be in a better condition for working up than they are directly after pulling off the green ears.

I did not intend to take so much time, because I wanted to answer any questions that might be asked on any points that I have not made clear, or upon any which might be regarded as questionable. I have my note book here, and I can give you the figures for everything. I will say, for the credit of the experiments that have been made, that there has been no guess work about them. Every foot of ground has been measured, and every inch, every pound of stalks weighed, and the weight and specific gravity of the juice, and the weight of the syrup obtained. Everything has been determined by pounds and ounces, by feet and inches. In regard to the facts, there is no question; the only thing is in regard to the practical results. I will say, however, in regard to the corn, that this experiment, although apparently in the teeth of so much testimony, is nevertheless in strict accordance with my results with the sorghum. I found that the juice was at its maximum, so far as the contents of sugar was concerned, when the seed was dry, hard, and ripe; and it raises a very large quantity of seed indeed and it is admirable food for cattle and for poultry; and by analogy I should expect, as I say, that the corn would give the best juice when its seed was hard and dry and ripe. As matter of fact, although it was but one experiment, I regarded it as not exceptional and one of very great importance.

I am much obliged to you for your courteous attention, and I would say that I have here a couple of samples of sugar, one made from corn stalks and the other from sorghum. They are both sugars of very high grade, will polarize between 90 and 92, I have no doubt, although I have not polarized these particular samples; but if there is anyone here who would like to examine them in that respect, I should be happy to let him take samples and satisfy himself that they are, as I said, equal in value to the refiner of the best average ten per cent. of the best Muscovado sugars from Louisiana and Cuba.

Mr. ———. I believe the Professor did not tell us the results of the freeze.

Prof. **Collier**. In every case I examined of the sorghum, I found the freeze had not affected it one whit. Indeed, the examination in one case showed a larger percentage of crystallizable sugar in the juice than was obtained just before the freeze about a week before; but inasmuch as the cane had been ripe for two months, I suspect it was probably due to drying, because the percentage of water at that time was a little less than it was the last time it had been examined. I do not believe that that increase of sugar was really owing to the development of more sugar, but was merely an apparent increase from the diminution of water. I will say that that does not account for the increase I have mentioned, as might seem to some of you. I omitted to mention the fact, that in all of these cases the water in the stalk was estimated, so that really the changes in the uncrystallizable sugars were actually changes in quantity, and not apparent changes, owing to the diminution or the increase of the water. The water was approximately the same from first to last, with the exception of the diminution after the freeze. I will say, also, that a subsequent examination was made of the stalks after a thaw. We had several days of oppressively warm weather after about a week of cold weather following the freeze of October 23d. One examination was made on the 29th of October, and then, about four or five days after, another examination was made. In the mean time, between the 29th of October and the 3d, 4th, or 5th of November, there had been several days of oppressively warm weather. We found then that the sugar in every case had fallen off greatly, and that confirmed the universal testimony that such weather is very injurious; but the frost was not harmful in the least.

Mr. Webb. I move that the convention now adjourn, in order to visit the Linen Mills, agreeably to the invitation which the convention has accepted.

The Chairman. Gentlemen of the convention, you all know that the convention voted yesterday afternoon that they would visit the Willimantic Linen Mills, at half past three o'clock this afternoon. At that time we were not aware that Prof. Collier would be here, and that we should be entertained with this address to which we have listened. I have just had an interview with the Professor, and he has consented, although he desires to leave, to remain this evening, so that any inquiries in regard to this subject may be made at the evening session. We will now adjourn to 7 o'clock.

EVENING SESSION.

The meeting was called to order at 7 o'clock by Vice-President Hyde.

The **Chairman.** The Convention adjourned this afternoon just at the point where the audience was very anxious to make inquiries of Prof. Collier. Those interrogatories are now in order.

Mr. **Robinson.** Will Prof. Collier detail his process of sugar-making?

Prof. **Collier.** I think the best way to try the experiment would be for some two or three farmers to club together and put in twenty-five or forty dollars apiece and get a mill. Fifty dollars laid out in getting a first-rate mill is an investment which, if you used the mill but a week, would pay for itself. That is, the increased amount of syrup or sugar which you would make above what you would obtain by the use of the hand-mill, only working a week, would pay for the mill. Of course, you can easily see that that would be so. For example, the boxes of the second-hand mill that we had (which was the best the government could afford) were all worn out, and we had not time to get new ones; they had been filled in with leather chips and wood chips, and instead of getting what the manufacturer of this mill assures me a new mill will give—68 or 70 per cent. of juice—we got only from 40 to 45 per cent. The difference is certainly 65 or 75 per cent., so that I should say, above all things, get a good mill. Determine the size you want, and then get a size larger. I think you might exercise economy in the outlay anywhere else better than in the mill.

Mr. **Hart.** What are the requisite fixtures for manufacturing sugar in a small way? You speak of two or three farmers combining.

Prof. **Collier.** I would get a mill which would require two horses. Such a mill, which would give seventy-five gallons of juice an hour easily, would probably cost not over $100—possibly $75. Then something is needed to hold the juice. I use empty liquor casks or barrels to hold the juice which may accumulate while the vessels which I am using in the manufacture may be full, and the barrels or casks are handy to put upon the scales, because every pound of juice is weighed. Besides, these barrels are convenient for storing up the juice. And, by the way, it does not want to be stored long. Besides a good mill, promptness through the whole operation is exceedingly important. I suspect that that was one of the difficulties with Prof. Goessmann in his experiments, that through an imperfect apparatus he was longer in boiling than he ought to have been, and consequently inverted more of his sugar. We have, as I say, barrels for holding the juice. Then we have what is called the defecating tank for removing the impurities from the juice. If it is from sorghum, it is of a greenish color; if from cornstalks, stripped in the ordinary condition, it is of a grayish, milky color, and from the butts of sorghum it will be of that color. Indeed, it is dark, and not transparent, from the large amount of suspended matter. The juice is put first in the defecating tank. (I am describing now the apparatus I am using.) This defecating tank is 2½ feet wide, 2½ feet deep, and about 4 feet long. The one I have (which was borrowed) is of copper, but sheet-iron would do just as well, and would not cost a quarter as much. This tank is set in brickwork, so that the fire plays not only under but around it; it has a flange so as to support it. The juice was heated, in most of my experiments, up to 82° centigrade—100° being the boiling point, and 0 the freezing point. But that is not indispensable, for I varied this in almost every way. But in the majority of my experiments I heated the juice as quickly as possible to 82° centigrade, and then added to the juice cream of lime, which I made by slacking a lump as big as my fist in water, precisely as if it was to be used for whitewashing, and then added about two or three gallons of water to the lime. I stirred this round, and then hastily poured it into another pail, so as to throw away any lumps which might be at the bottom which had not thoroughly slacked. I wanted to have the lime slacked and all in a state of very fine sub division. You will see the point in a moment. After the juice had been heated up to 82° centigrade, this cream of lime was added, and another person who was assisting me stirred it up until the juice was rendered slightly alkaline—as little as possible. I would say here that the juice of all these plants, when first expressed, is slightly acid, from the presence of vegetable organic acids in them, as indicated by means of blue litmus paper, which you will find at any drug store, I presume. If you take a slip of this blue litmus paper and dip it into the juice of cornstalks or sorghum, it will turn red, on account of the acid in the juice. Now you add lime and mix it with the juice until the juice will no longer redden the litmus paper, but will turn it a purple color, not a decided blue. If it does, you have got a little too much lime in. You want to put in just enough lime to neutralize the acid. If you get a little too much in you will probably get a little darker syrup than you would like, and it is undesirable on that account; but I have aimed to put in just enough lime to render the juice slightly alkaline—to make the litmus paper neither red nor blue, but purple. After this is done, you will at once see that the juice has something like a curd in it; it is coagulated. There is formed a precipitate all through the mass, which will subside to the bottom very speedily. You then raise the heat to the boiling point, and boil it as little as you can. I do not know that it would do any harm to boil it half an hour. I did not boil it half a minute. As soon as it began to boil the fire was drawn from under the tank, and the effect of the lime now is to raise a copious scum. Many of the impurities of the juice rise as a scum, and besides that, a very heavy sediment subsides slowly to the bottom. After drawing the fire we removed this scum with a fine wire gauze skimmer, which was about as big as my two hands, and then let the juice cool down to about 84° or 85°C., and at that time this sediment had subsided, and the liquor, if the defecation was properly conducted, would be as clear as light-colored rain water, having a very little shade of brown. Then, by means of a spigot, which was nearly at the bottom of this tank, I drew off about a quart, because a little of this sediment had settled in the spigot, and about a quart would come off turbid, containing a little of the sediment, and then, by drawing it off carefully into a tub, we could draw successive tubsful of this until at least nineteen-twentieths of the liquid had been removed, almost perfectly free from any of this sediment.

Now this juice, which is slightly alkaline, is put in an evaporator. I do not think this process which I am about to describe is necessary, for I have had sent to me from different parts of the country as good syrups as any I have made,—made by ordinary farmers, where the molasses was just as bright as any I had secured, where they did not take this step I am going to describe. I added to the juice a solution of *sulphurous* acid (not sulphuric acid), which, if it is right, you will recognize by its smelling precisely as a sulphur match does when burning. If this is necessary, it is practicable to be used, because it can be prepared for two or three cents a gallon, and will not add one-twentieth of a cent a pound to the cost of the sugar. I added to the juice, as it was drawn from the tank, enough of this solution to render the juice again acid, as indicated by the litmus paper, which was now turned red again. Then I evaporated just as fast as I could, skimming as long as was necessary. I boiled it down until the syrup would gather in big bubbles that broke with a puff. Any one who has made maple sugar understands it. At that time there is very great danger of the syrup scorching, especially if you use such a pan as I did. My pan was made of ordinary galvanized iron, instead of ordinary sheet-iron, as I could not get sheet-iron heavy enough in the market. It was an ordinary pan, made of two widths of galvanized iron, which was riveted about every two inches, and soldered, about eight inches deep, four feet wide, and about ten feet long, and it had a flange of about an inch on the top. There was built around it, so as to stiffen it, a frame of two-inch rough pine, and this flange was nailed down on top of the frame. I suppose everybody understands how that was. This frame sat upon brick-work, and a fire was built underneath the pan. Of course, the fire playing right against the bottom of the pan, there was very great danger of scorching, but I worked that pan this season with more than forty experiments, and I never scorched one batch. It requires care: that is all. I managed the fire so that when the syrup reached the last steps of the concentration there was a bed of coals, and then, if there was any danger of scorching I would shake a little water upon the coals, so as to quench them a little. When it had reached this puffy boil it was drawn off into tubs, weighed, and set aside in a warm place to crystallize. Then it was put into grain bags (if it had been on a sugar plantation it would have been put into the centrifugal) and the molasses pressed out; then opened the bags and sprinkled a little water over it, not more than a teacupful on a hundred pounds, sometimes hardly that; stirred it into a thick mush, and again pressed it, and obtained such sugar as you saw here from the cornstalks, and very much better sugar from the sorghums. That was the operation.

The last portion in the tank, that did not run off clear of sediment, I put into a plaited bag-filter. That was made by taking two grain bags, cutting one lengthwise, and having it sewed up into a bag of the same length that it was originally, but only half as wide, and then I took another bag and put it into this. Of course that compelled it to plait up in this smaller bag; and then I filled this inner bag with hay, as hard as I could ram it in, and then it was nailed on to a wooden frame and put in a barrel; and into this rude filter this sediment was poured, and the juice which ran through clear was added to the evaporator, so as to save as much as possible.

QUESTION. What kind of mill do you recommend? Would the Victor mill be suitable?

Prof. COLLIER. I would like to say that, within ten days, I have heard that the Commissioner had been charged with being in league with some manufacturers of mills. If I should answer that question, the justice of the attack would be manifest if you should make such a charge against me. The Victor mill is the mill we have used, only it was an old one, made some twenty years ago. The manufacture of that mill is still carried on. I presume there are three or four manufacturers who make good mills.

Mr. WELLS of Hebron. I have been engaged a little in the manufacture of sorghums. In 1864 I used a Victor mill, and what is known as the "rocker pan." I will ask if there is any objection to the use of such a pan.

Prof. **Collier.** I have no doubt that some of those pans are very much better for practical purposes than the pan I have. There is this, however, to be said: I could evaporate 175 gallons easily in three hours and a half with this open pan that I have described, and got excellent results with it, and I could drive it along so that the syrup would be boiling from one end of the pan to the other. This open pan, with a flat bottom, gave me entire satisfaction, and there is no patent on it. It can be made in any place where there is sheet-iron. With the least bit of ingenuity any man can make one for himself.

Mr. **Hale.** I have seen considerable of what is called, I believe, "Minnesota Amber Sugar Cane." Is it anything more than a variety of sorghum to which you have referred?

Prof. **Collier.** It is the one I had reference to as the "Early Amber." It makes a syrup that will readily crystallize, but I found that it did not differ one whit from all the others, except that it would reach that condition about six weeks earlier than some other varieties would. Now, here in Connecticut, or anywhere, for that matter, my advice would be to those who might wish to try it,—get the earliest variety possible, and get the seed, if possible, from a northern locality, and then put in the bulk of the crop of that variety; and if you find that you have three or four weeks to spare at the end of the season, try a little later variety, and it is not at all improbable that you may have two or three varieties coming into a ripe condition in successive periods, so that you could begin with even a small amount, and work off the entire crop. But by no means risk a variety which is late in maturing.

Mr. **Wetherell.** I would like to ask the Professor if he knows the kind that Prof. Goessmann used?

Prof. **Collier.** He called it the "Early Amber." This is a natural hybrid, as I understand it, which was discovered and propagated in Minnesota. I think we have a great many persons in New England who, taking these plants which are so hardy and coarse, would produce within a few years plants that would mature much earlier than any known varieties.

Mr. LYMAN. This is an old subject. I remember that in 1867 I traveled in Ohio, when they had the sorghum fever, and, as I understand it, the trial at the Massachusetts Agricultural College was not very successful, for some reason. I would like to know the reason, if the Professor can tell us, why they did not succeed in crystallizing their syrup and making it into sugar.

Prof. COLLIER. I have no doubt the reason was that they did not work it up at the right time. Gentlemen will remember that I said this afternoon that you can make syrup at any period, almost, in the growth of the cane. You cannot make the maximum amount of syrup, but you can make syrup. But whether you can make a syrup which will crystallize depends upon these two facts: first, the amount of crystallizable sugar which is in the syrup, of course, and next, upon the relative amount of uncrystallizable sugar in the syrup. If you have in any juice as much uncrystallizable sugar as of crystallizable sugar, nobody can make a syrup from that juice which will crystallize. Though half the sugar is crystallizable, the uncrystallizable sugar will hold it in solution. But anybody can fail. Some persons would blunder at anything. I do not think that one out of a hundred of our farmers could possibly fail in making a crystallizable syrup out of a juice which would give 13, or 14, or 12 per cent. of crystallizable sugar to one or one and a half per cent. of uncrystallizable sugar. The only trouble is, they have not had that kind of juice.

I am not unfamiliar with what has been done in the past. The thing which has surprised me more than anything else is that so much has been known in regard to this matter, for so long a time, and so little has been done. I have no question that there are fifty people in this hall who, if their attention had been directed to this subject any time within fifty years, without prejudice, the whole problem would have been solved. But we have all been prejudiced by these failures in the past. If it occurred to us, " Why, there is sugar in cornstalks, and why can we not get it?" we would say, "Somebody must have tried it and failed," and we therefore let it slide. But there is no knack about it at all. It is just as easy as anything can be.

Now, I want to insist upon this one thing: the stalks must be worked for the best results, no matter what the variety is, when they give every evidence of maturity,—the death of the lower blades, the hard dry, ripe seed.

Mr. Aiken of South Carolina, made this season a lot of sorghum syrup, and he said he didn't care anything about the sugar; he could sell all the syrup he could make. He had a variety that gave him so much sorghum to the acre that he did not care for the "Early Amber." He sent me a cane from Cokesbury, S. C., which weighed seven pounds, stripped, and was seventeen feet tall. I examined that cane, and although it was not in the right condition, still the juice which I got was sufficient to give me a nice little batch of sugar, which I sent down to him, to show him that there was no trouble in making sugar from that cane. Of course I would never advise a person in South Carolina to plant the "Early Amber," because he can get a very much larger crop of cane from an acre than he can of that variety. I would never advise anybody in Connecticut or New England to attempt, for the first time, anything later than the "Early Amber" in maturing.

Mr. **Hart**. I would like to ask the gentleman here who said he had experimented somewhat with sorghum if he succeeded in making sugar?

Mr. **Wells**. No, sir. We got sorghum syrup, but no sugar. We were never able to crystallize it at all. Our practice was to cut it before the seed had ripened. We saved a great many samples, but never, except in one case, had any that crystallized. We put it away in vials, and one small lot threw down a few crystals. We never got any sugar, although we worked a good deal of cane in two seasons—1865 and '66.

Prof. **Collier**. Did you treat with lime?

Mr. **Wells**. No, sir.

Prof. **Collier.** I do not know, I only judge from analogy, but I have very little doubt that the action of the acids, if not neutralized, would be such that, in evaporation, it would cause the inversion of the sugar, and consequently I think there is no doubt that if he had matured his cane, and had treated the juice with lime, he would have succeeded just as well as I did.

Mr. **Bill.** I would inquire of the gentleman if he ever estimated about how many dollars a gallon his sorghum syrup cost him?

Mr. **Wells.** We estimated that our cane cost us no more than it would to grow a crop of corn, and we obtained something like $300 worth of syrup from one acre.

Mr. **Bill.** I would say, he was much more fortunate than I was. I came in earlier, and invested a good deal of money, and was minus all I put in.

Mr. **Wells.** We built our mill at a cost of $700. We worked up our own cane and worked for our neighbors, and in thirty days we had our $700 back. That was our result.

I would like to ask the Professor one question. Is there any difficulty in extracting the juice from dry, ripe stalks, as ripe as he represents? Is it not difficult to grind it in that state?

Prof. **Collier.** There is no difficulty in expressing the juice from the stalks if they are quite ripe. I found that the stalks of corn from which I had taken the thoroughly ripened ears, when put through the mill, gave me a percentage of juice quite as great as the percentage of juice I got from stalks which were cut when the ears were green, and sold as green-corn, and I found that the amount of water in these stalks, all the way through, from the time when the seed-head first appeared until the heavy freeze of October 23d, was practically the same. But the amount of sugar differed very much. It is practically just as juicy when it is thoroughly ripe as it is when it is thoroughly green. I do not mean when it is a foot or eighteen inches high, but after it has got so any one would think of working it.

The **Chairman.** I understand how fond you all are of the sweets of life, but the time has passed for the regular exercises of the evening by nearly three-quarters of an hour. If it is not your pleasure to pursue this matter further by a vote, I suppose the Chair should call the meeting to order for the regular exercises of the evening.

The Vice-President then requested Mr. J. J. **Webb** of New Haven, to take the chair, who presided during the remainder of the evening session.

The **Chairman**. The first paper on the programme is one upon "Fruits and Fruit Gardens," by Mr. **Alfred** H. **Augur**, whom I have the pleasure of introducing to you.

FRUITS AND FRUIT GARDENS FOR FARMERS.

BY ALFRED H. AUGUR.

We have before us this evening a subject of interest, which should be of practical importance, not only to every one who makes agriculture a business, but also to every person who has land enough for a garden or yard. The art of fruit growing is, and has been since the creation of the world, one of the noblest and most honorable pursuits which has ever engaged the attention of man. Fruit culture was man's first occupation, commanded by God and specially blest by Him, and would doubtless have continued such but for man's fall. Through all the ages which have passed, as century has succeeded century, and as one year has followed another, this industry has been rapidly pushed towards perfection. The advance that has been made in our own day has been most wonderful. In place of the inferior fruit enjoyed by our forefathers, we now have specimens of such beauty, rich and luscious flavor, and fine texture, as to attract the eye, gratify the taste, and win the admiration of all.

Think of the quantity which our country now produces, and the yearly increasing figures which inform us of her exports, and we shall be able to comprehend in a measure how great and important a place this branch of agriculture has now reached. Thus we are led to see the demand for our fruit at home and abroad, and to lay our plans for its production in such a way as to be able to reap our share of the profits.

THE VALUE OF FRUIT TO THE FARMER.

First. Every farm increases in value in proportion to the amount of good fruit it produces, also to the discretion exercised by the owner in the selection of proper varieties, their adaptedness to the various soils of the farm, and to the thrift and condition in which he keeps his trees, vines, etc. Planting numerous orchards and vineyards, largely of leading varieties, brings the owner good interest, and yearly increases his principal.

Almost the first question we hear from a person in search of a good place for a home is, How much fruit have you on the place? and, What varieties? and if we can answer these questions satisfactorily, it will do much to secure a favorable result.

Second. As a farm crop, fruit takes a prominent position, and is one which generally pays best. To be sure, this varies according to location, markets, soil, and some other circumstances; what may be one farmer's most paying kind may be the contrary with another. From apples, pears, peaches, grapes, strawberries, and the other species should be selected those that offer the best chances of success, and will be most apt to bring the grower the best compensation.

Fruit-growing is a business which not only benefits the farmer, but also the public: this cannot be said of all crops. Tobacco, for instance, in years gone by, if not at the present time, has been a crop which has brought the grower large returns; but is it a benefit to the country? It is one of the most exhaustive crops which a farmer can raise, and if long continued in will tend to lower the value and fertility of any farm.

FRUIT AS ARTICLES OF DIET.

Many make fruit an important article of diet, and have become so much attached to it that they can scarcely go without it, even when necessity compels them to do so. Our years of plenty, in a great measure, have brought this about. When fruit is abundant, and prices run low, people use freely, thus getting more habituated to its use and realizing more and more its value as an article of food. Such our Creator intended it to be, for we read, "And God said, behold I have given you every herb bearing seed which is upon the face of all the earth, and every tree in the which is the fruit of a tree yielding seed; to you it shall be for meat." "And out of the ground made the Lord God to grow every tree that is pleasant to the sight, and good for food."

Fruit adds much to the enjoyments of life. Seldom, if ever, do we meet a person who does not like fruit of some kind, or in some form, while most people look upon it with favor in all of its varieties. Many of our fruits are of so high and pleasant a flavor as to make them general favorites everywhere, and the enormous quantities annually consumed prove this fact.

Among these favorites we find strawberries and peaches to be quite prominent. Many of our city people, as well as the farmer and his family, think they must have their berries three times a day in their season, and almost every family will procure a supply of peaches for immediate consumption and preserving for the year's use.

The production of good fruit, the propagating and disseminating of new and improved varieties, and the general culture of fruit, all give enjoyment to the farmer, provided he has not mistaken his calling, and has that degree of interest in his work which invariably insures success. Man's nature is continually demanding some luxuries to gratify its cravings; supplying these wants with articles not injurious to good health can only bring true enjoyment. We find that fruit in almost endless variety comes within this sphere. It does not destroy but promotes good health.

Most physicians advise its use, and our own experience confirms the fact that it is beneficial and necessary to secure and retain sound constitutions. How needful is its presence in the sick room! When almost every delicacy is denied, a little ripe fruit is seldom refused. It also delights the eyes of the invalid, and helps to divert the mind and turn the thoughts from weariness and despondency to pleasantness and hope. Fruit is one of nature's best remedies for the ills and diseases of the human frame.

Dr. Trall in his *Hydropathic Encyclopedia* says: "As a general rule all sweet and sub-acid fruits, when full grown and perfectly ripe, are most wholesome if eaten without any preparation or seasoning. If, however, they are too sour, a little sugar may be added, and the very acid fruits, as well as those not perfectly ripe, are improved by stewing and sweetening. I have never found good grapes to disagree or produce even temporary inconvenience in the most delicate stomachs. I regard them as always preferable without cooking. Apples, pears, and peaches always agree with all healthy stomachs, and the worst dyspeptics may soon acquire the habit of eating them, not only with apparent impunity, but with absolute advantage, by partaking of a very little at first and gradually increasing the quantity."

In passing the allotted seasons of our various fruits, we are led to see how wise and kind our Benefactor has been in adapting them so perfectly to the wants and use of his subjects.

Let us notice a succession of fruits at our disposal, covering the entire time from June 1st to June 1st: The strawberry, ripening from June 1st to July 15th; cherries from June 10th to July 20th; the raspberry from July 1st to August 5th; the currant July to August; the blackberry from July 20th to September 15th; the gooseberry July and August; the mulberry for six weeks in July and August; the grape from August 20th to March 1st; the pear from July 20th to April; the apple from July 20th through the entire year; the peach from July 25th to November; the quince, for preserving and baking, September to December; the apricot, plum, and nectarine, July and August to November. Thus we observe that our round of fruits fill the whole year, so that, except in April and May, it is easy to have two, three, or more species at a time, beside a multitudinous variety of each.

Dropping the subject of the succession of the different fruits, let us now notice some varieties and their culture.

THE STRAWBERRY.

With each new year comes a long list of new varieties, each demanding the attention and patronage of the farmer and grower. Most of them are claimed to be superior to anything ever before offered to the public. We find, however, upon trial, that many of them, although possessing some good qualities, do not come up to some of our old standard sorts in point of profit. Occasionally there are exceptions to this, and we secure plants of a variety which proves to be just adapted to our soil, and we find more money in growing it than we do in cultivating other kinds. Now how shall we determine which these are—by our own experience, or by that of others? I would say, by both. We should use all possible precaution, when procuring our plants, to obtain those which come well recommended by disinterested and responsible parties; then by giving them a thorough test upon our own grounds we shall find whether they are worthy to remain with us. There are many choice and valuable varieties of strawberries, and our growers would probably disagree if asked to name the best berry for field culture.

One of our producers would say, there is nothing which sells as well as the Chas. Downing; another would say that the Monarch of the West, Seth Boyden, or Duncan is good enough for him; another, that there is nothing which yields like the Wilson, Crescent Seedling, or Champion; still another would want larger berries, such as the Sharpless, President Lincoln, Great American, and the like. These all differ in value according to soil, location, markets, etc.

We find that strawberries are generally grown under one of three different systems of culture:

First, Hill culture, in single rows, usually set from two and one-half to three feet apart, and the plants fifteen inches apart in the row. Where surplus plants are not an object, this is a desirable mode of culture, as it is much easier to keep the weeds under subjection, and larger berries are produced in this way than under the following systems.

Second, Bed or triple-row culture, letting the plants in the side rows alternate with those in the center row. In following out this system the side rows are obtained by training young plants from the center row, allowing the triple row to be from one and one-half to two feet in width, with spaces of two feet between rows.

Third, Matted rows, setting the plants in spring, in rows from three to six feet apart, and allowing them to run. The main points in either case are a fertile, mellow soil, good varieties, and absolutely clean, thorough culture, with a good winter protection.

Failures in berry culture usually result from imperfect drainage, a low state of fertilization, or neglect in cultivating and mulching. Many of our farmers do not supply their own tables with this luxury, but put themselves to the inconvenience of getting them from the dealer or traveling some distance to a grower after them, while many others start with enthusiasm, resolved upon having a good bed for family use next year. So a few plants are obtained and carefully set in one corner of the garden, or some other convenient spot. These are well attended to for a time, but as the rush of the season comes on the strawberries are forgotten, and when our friend comes to review his plants, he finds that the grass and weeds have taken full possession, and are determined to remain, so the plants are given up. Every farmer should have a good plot of strawberries, renewed every two or three years with young plants, which should be kept free from all weeds.

RASPBERRIES.

This fruit is more easily cultivated than the former, and every farmer can at least have a small patch in the garden if he has no desire to enter into its culture in the field. Too many of our farmers neglect it altogether, thus obliging their wives and daughters to seek a scanty supply from the wild bushes which may chance to grow by the fences and hedgerows of the farm.

Of the Black Caps, the Doolittle and Mammoth Cluster have been our leading varieties. Of those recently introduced the Gregg promises well.

The selection of the red varieties which we should grow requires more thought. The hardy kinds are the most desirable, as others need protection in winter. This our farmers are apt to overlook in the hurry of finishing up their fall work, or to put it off until it is impossible.

As a hardy red raspberry, the Turner is highly recommended. Plants set in rows six feet apart, and four feet in the row can be cultivated both ways, unless wired, in which case clean culture should be given one way. For tying to wires, corn husks will be found quite serviceable, only one tie being necessary; they are also handy on the grape trellis.

CURRANTS.

A few bushes of the improved varieties, such as the Cherry, La Versaillaise, and White Grape, should be grown on every farm. These, when kept under good cultivation, will be found more profitable, and far superior to the common or wild currant. Although possessing much acidity, there is more sugar found here than in the strawberry.

CHERRIES.

Among the various fruit trees found upon any farm, those producing the first ripe fruit of the year are naturally looked upon with an unusual degree of interest, as the season approaches. These are the cherry trees found in limited number and variety upon almost all farms. Scarcely any species of fruit has been so much improved as the cherry. Our ancestors did not take the interest, devote the time, or exercise the patience necessary to the advancement in pomology which marks the present time; consequently they knew little of the delicious flavors and large size which have recently been brought out in this fruit. Almost all old cherry trees produce fruit of medium or small size, much of which is extremely sour, and brings a wrinkle to the lips. To those whose trees bear such fruit, and to those who relish a good thing, I say, keep up with the times, and set a few trees of improved varieties now and then, giving them proper care and treatment, and you will soon be rewarded by their production of choice fruit.

Some difficulties are found in the culture of cherries, as also in other fruits. Among these are the black aphis, which works upon the leaves, and the rose bugs and birds which feast upon the fruit.

The following are a few among the many good varieties: Early Purple Guigne, Coe's Transparent, Gov. Wood, Black Tartarian, Black Eagle, Downer's Late Red, Rockport Biggareau, and for cooking, the Early Richmond. Cherry trees are well adapted to street planting.

GRAPES.

We find a great deficiency in the cultivation of this fruit throughout our commonwealth. Our vines are too often suffered to go unpruned and unfertilized, and the result is, as might reasonably be expected, imperfect fruit. The following varieties are desirable for every farmer, viz.: Moore's Early, Worden's Seedling, Hartford Prolific, Concord, Delaware, Ives Seedling, and of the white grapes, the Martha and Lady. Among the new varieties soon to be disseminated are the Prentiss and Niagara, both white grapes of promise. On many points in the culture of this fruit growers differ, but its adaptability to light soils seems to be universally admitted.

PEACHES.

For some years past, our farmers have seemed to think that success with this fruit was impossible, owing to the ravages of the Yellows making the tree short-lived. Indications for their culture in the future are more hopeful, and many of our Connecticut growers are once more setting large orchards. For a succession of peaches for use in the family the following is a good selection: Waterloo, Amsden, Early Louise, Troth's Early, Mountain Rose, Large Early York, Crawford's Early, Hance's Golden Rareripe, Old Mixon free, Crawford's Late, Stump the World. And for high altitude, or places where a killing frost doesn't come until after the middle of October, the Smock, Keyport White, Silver Medal, and Brandywine.

THE PLUM.

But few plums are grown in our State. Those who persevere in destroying the curculio raise fine fruit, which always has a ready sale at remunerative prices. Any farmer willing to devote the time necessary to the successful cultivation of this fruit need have no fear of gluts in the market. The Lombard, Reine Claude de Bavay, Coe's Golden Drop, Bradshaw, Green Gage, and Hudson River Purple Egg are among choice varieties. Those who have large yards for fowls should try to raise a few plums.

THE QUINCE.

Like the plum, this fruit never goes begging in the markets, and is one of the fruit grower's most paying crops. A moist but not wet soil is best adapted to its culture.

Choice selected trees, kept under good cultivation, seldom fail to be a profitable investment. The Apple or Orange Quince is our leading variety, and we have yet to find one which fully takes its place. Among new varieties the Champion promises well.

THE PEAR.

We have here a fruit which covers a longer period in its season than any which we have before taken up, and is second to none but the apple. Good trees, set now and well cared for will last for years, and will not only benefit us, but those who follow us. They are one of the richest legacies which we can leave.

For home use the following are valuable: Doyenne d'Ete, Beurre Giffard, Dearborn's Seedling, Clapp's Favorite, Bartlett, Seckel, Beurre Bosc, Goodale, Sheldon, Beurre Superfin, Onondaga, Howell, Beurre d'Anjou, Mt. Vernon, Lawrence, and Beurre d'Langelier. New sorts of promise are Chambers, Rutter, and Talmadge.

I do not mean to say that the varieties in this list, or the preceding ones which I have given, are all which are desirable. The list is capable of almost indefinite extension, but a few choice varieties will give more satisfaction than undue enlargement.

THE APPLE.

This is our main or principal fruit, and with good facilities for keeping, one which may be enjoyed through the whole year. In many places, in favorable seasons, large quantities are produced ; this makes a depression in prices, and sometimes tends to check the setting of young trees, and to discourage the farmers who have no near market, but are obliged to ship. Notwithstanding this, they are a crop which generally gives the producer good returns. Among the varieties which every farmer should have for home use are the Baldwin, Rhode Island Greening, Roxbury Russet, Gravenstein, Fall Pippin, Fameuse, Hubbardston Nonesuch, Primate, Red Astrachan, Early Harvest. For sweet apples, the Sweet Bough, Golden Sweet, Jersey Sweet, Talman's Sweet, Pound Sweet, Ladies' Sweet, and Sweet Russet. For market, the Rhode Island Greening, Baldwin, and Roxbury Russet are most valuable.

Orchards set with sweet apples may be made profitable pastures for swine. As the immature fruit falls it is consumed, many insects destroyed, the trees are kept well fertilized, and a good crop of good apples is obtained, which can be picked and sold, or left for feed.

In many old orchards within our observation decay is doing its work, and necessitates the removal of some trees every year, while many which are allowed to remain are almost worthless. These orchards will soon be gone, and unless the owners feel interested in starting new ones to take their places, they will eventually find themselves without a supply of fruit. Farmers should not wait until their old orchards give out before planting new ones ; if so, several years of fruiting will be lost. Young orchards should be set frequently, and a good return will be realized.

FRUIT GARDENS.

Every farmer should not only have a good vegetable, but also a good fruit garden, entirely separate and independent of each other, and devoted to the use and enjoyment of the family. The fruit garden should receive as good care and attention as the one in which vegetables are grown.

The idea of setting fruit trees and plants in places which are unfit for other purposes, and then leaving them without fertilization, culture, and pruning, to be choked by grass and weeds, is as poor policy and economy as any one can practice. Scarcely anything grown upon the farm, or in the garden, is forced to endure the hardship and neglect to which fruit is so often subjected. Many farmers actually grudge the ground necessary for the perfect growth and development of a tree or plant, or are afraid of a little trouble in driving a team around it, and yet these same men, while walking through the orchards of their neighbors, are as eager for a good apple, pear, or peach as any one. Fruit gardens should be so arranged as to conform to the tastes of those for whom they are designed. No tree or plant which does not produce fruit of the best quality and productiveness, and is not a favorite in its season with all, or at least one of its intended consumers, should be allowed a place upon this valuable ground merely because they may chance to be cheap or to look well. In some fruit gardens we find strawberries alone, but generally a mixture of our leading fruits.

In the selection of all fruits for family use, the longest time of ripening of each kind of fruit should be one aim. This will give a good supply for a long time, without the waste which would occur with too large a quantity of one variety, excepting those grown for winter use.

For strawberries for home use, by choosing suitable varieties, without unusual care, a period of nearly six weeks fruiting is obtained. With a slight additional outlay, as will be seen in the sketch, the period of fruitage can be extended to two months.

In following out this plan, the plants should be set in rows running east and west. On the north and south sides of this plot are tight board fences, about five feet in height. Having the ground suitably prepared, commence setting the plants as early in the spring as possible, by the side of the north fence. For the first three rows of this patch, set plants of the best early varieties now grown. In the first row we will place the Crystal City, said to be the earliest of all; in the second, the

CRYSTAL CITY.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

CRESCENT.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

DUNCAN.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

DUCHESSE.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

WILSON.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

CHAS. DOWNING.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

SETH BOYDEN.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

MONARCH.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

SHARPLESS.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

GT. AMERICAN.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

CHAMPION.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

KENTUCKY.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

GLENDALE.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

Crescent Seedling, and in the third the Duncan, keeping the rows about eighteen inches apart, and the plants in single hills fifteen inches apart. Directly south of third row place a board a foot in width, held up by stakes. Attach to the fence with butts a frame made of three-inch strips of board, covered with oiled cloth. This frame should be of sufficient size to cover these first three rows of plants, and be hung high enough on the fence to give a gentle slope when down. In the fall, about the time the ground commences to freeze for winter, mulch well with leaves, and keep them covered with this frame. Early in the spring remove the leaves, and raise the cloth during warm days, covering them again with the frame on cold nights.

These plants will give us our first berries, which will be very early. In the fourth row set the Duchesse, an early berry to ripen, next to those in the frame. In the next five rows can be set any varieties ripening in the medium or usual time.

For last five rows set late varieties, such as the Gt. American, Champion, or Windsor Chief, Kentucky, and Glendale, having the Glendale rows next to the board fence on the south. Mulch all of these rows well, and let that covering the last three rows remain over the plants some time after the rest has been removed. These will give us our late berries, which should fruit until the middle of July.

As I have already stated, a good number of varieties of each species should be set for family use, making the season long and giving an even supply. But in growing fruits for markets which are distant, we should aim to produce quantities of a few of the best and most salable sorts.

The future prosperity of this industry will depend upon the interest which the rising generation take in it. Too many of our young people are leaving the farm every year for more promising openings in the city. How shall we stop them and keep them on the farm? Certainly not by the penurious and meager way of living and working to which many of our farmers still adhere.

This is an age of inventions and improvements, and we should not follow in the ruts in which our predecessors traveled. Create an interest for fruit and rural affairs in your children. Beautify the homestead and make it attractive. Strive to secure their services, and hearty coöperation, and you will do much to perpetuate and extend an interest in agriculture and benefit our commonwealth.

The CHAIRMAN. The subject of the next paper is "The Compensations of Agriculture," by Mr. HUBBARD.

THE COMPENSATIONS OF AGRICULTURE.

BY J. M. HUBBARD.

The question, what farmers actually receive for their investment of capital, skill, and labor, is one of some importance, but it is not the one toward the solution of which I shall try to contribute something upon this occasion. That task is one that I leave to census-takers and statistical bureaus, and pass to consider a question of far greater interest and importance, What does agriculture *offer?* What *might* the farmer receive for his investment? Of what compensations is his vocation capable, and upon what conditions are they awarded? It is in some such sense as this that I construe my title, and in this general direction I propose to pursue my inquiries.

I do not pretend to approach this subject with indifference, perhaps not even with impartiality. I cannot claim to be disinterested. I am a farmer, the descendant of generations of farmers, and am bound to that vocation by ties which I have no expectation of breaking nor wish to break. A farmer speaking to farmers, I shall attempt to show that our vocation holds in its hands abundant compensations, and bestows them upon reasonable conditions. I hope to show that the mistress whom we serve is not unjust or ungenerous; that if she demands, as she certainly does, faithful service, she is not unmindful of it and does not refuse adequate payment. I desire to show this because I believe it to be a truth so important as to justify statement, illustration, and enforcement, reiterated again and again. If, however, I am mistaken in this assumption, if agriculture cannot or will not give fair pay for faithful service, if those who serve in this vocation can never hope to be other than ill-paid drudges, then let this fact be shown. I believe that farming ought to pay, and can be made to pay, but I certainly do not wish to mislead anybody or be misled myself upon a question of such vital importance. I do not wish to uphold a profitless agriculture. If that is and must be its character, let it go down to the grave of popular condemnation and aversion, "unwept, unhonored, and unsung."

The truth in regard to this matter is of especial importance for the guidance of those who are considering that important question, the choice of a vocation for life. It is not desirable, of course, that all should be farmers, but those to whom nature has given a taste for rural life, lively interest in growing things, the faculty of aiding, controlling and developing this growth, and deep satisfaction in the work, it would seem that she intended to be farmers as obviously as she has fitted and intended others to be mechanics, artists, or exchangers. It would seem so, I say, but unless farming pays, let none of them become farmers. And, indeed, if farming don't pay, perhaps those of us who have made choice of it as our calling, and have followed it for many years, had better consider seriously the question of change. To be sure, change would involve loss, but after we had once found the thing that did pay, the loss would cease, whereas if we continue in a non-paying business we face a never-ending loss.

As to what we shall all undertake when we quit farming, I can only make suggestions. Some of us might peddle lightning rods, some might take insurance agencies, a great many might go around the country teasing people to buy articles which they didn't want, at prices many times their value. All these occupations seem to have great elasticity in regard to the numbers to whom they can furnish employment. And yet I bethink me now that if there were no farmers to buy, the operations of this class of business men would be very largely curtailed, and I am afraid we couldn't all of us find profitable situations among them.

It is of course impossible to speak seriously of the suggestion that farmers should all quit their occupation; but one may, I think, very seriously ask if the absolutely essential position that agriculture holds among the industries of earth does not afford ground for a fair presumption and a strong presumption that it can and will pay fairly those who serve it faithfully. If not, the remedy is in their own hands. Things which the world can do without, it may pay for adequately or not, as caprice may dictate, but agricultural products it must have, and it must pay a price sufficient to induce the holders of these products to part with them. The world cannot say to the farmers, we will do without your products sooner than pay the price you demand for them, for that alternative is not open to it. It may say to the individual farmer, we will not pay what you demand, because others will supply us more cheaply; and if such is indeed the case, the individual must give way, and if he finds that others are able to undersell him, he must either contrive to improve his methods so as to produce at less cost, or he must abandon that line of production and try something else. This is not a very pleasant doctrine to teach; it is not a pleasant experience to have, but it is something to which all are liable, and which nearly all partake of in some degree. It is not peculiar to agriculture. In all vocations competition is the unresting, unpitying power which compels every man to find the task for which he is best fitted by driving him away from every other. So I think that the farmer who grumbles at his occupation because it doesn't pay, and still continues to follow it, is somewhat inconsistent. To him and to us all the world's activities are open, and if anything else would pay him better, let him go at it. If nothing else would pay as well, there is ground for a suspicion that he overestimates the value of his services.

Perhaps I shall have no better occasion than this to ask and answer as best I may the question, What is good pay? I judge that an employer gives good pay when he gives for a certain kind and amount of service as much as any one else will give. A job pays well when one can earn at it as much as he could at anything else. The same is true of a trade, a business, or a profession. The market rate for service of any kind is generally a fair one. The standard which this rule adopts is by no means a perfect one, but it is the best we have. It is not necessary that a man should receive all that he would like to in order to be well paid. If he receives as much for what he is doing as the same expenditure of ability and energy would bring in any other employment, he is receiving good pay. One trouble with most of us is that we are fond of testing the sufficiency of our pay by the standard of our own desires rather than by the world's judgment of the value of our service. We are hardly willing to accept market rates for our wares.

It may seem to some of you like giving away my case to say frankly at this stage of the argument that agriculture does not furnish the opportunities for accumulating great wealth that many other avocations do. Great fortunes are not earned —they are acquired or won, we say, instinctively using the phraseology of the games of skill and chance when we speak of the process by which they are acquired. Skill and good fortune combined give a man power in some form over his fellow men, and out of their earnings comes the tribute which builds his fortune. He may control an important link in the system of transportation, which is so essential to the world's business that he may levy tribute on that business almost at his will. He may control some form or process of manufacture which is so advantageous to mankind that they will pay many times its cost rather than do without it. Or his power may spring simply from skill in managing other men, or in using capital in some of the many avenues of trade. One man may be able to direct the labors of a thousand men to so much better advantage than they themselves could, that they may pay him heavy tribute, and still be better off than if they tried to direct their own efforts.

The natural leaders of men are few, while those who are willing to be led, and need to be led, are many. And though every man is as much at liberty to try leading as to be content with following, yet, after the habit of depending upon some leader is established, he is no more free, except in theory; he must be led, and he must pay for the leading.

I do not mention these things in the way of criticism. As mankind are, leadership is necessary to progress, and in the benefits of progress followers as well as leaders have a share. So, too, a monopoly may not be a thing altogether bad. We all agree to a system which stimulates the efforts of the inventor by offering him a monopoly of his devices for a term of years as a reward for his risks and labors. It is only when the power which monopoly, or leadership, or business skill and position give is used oppressively, that they become evils.

They are mentioned here simply for the sake of showing how very unfavorable the conditions of agriculture are for anything in this line. How, for instance, would any farmer establish a monopoly of any farm product? Perhaps in a very small way, and for a brief period, something of the kind may have existed. The seed of some new variety of plant may be to the fortunate owner a monopoly for a single season, but he can only make it profitable by sacrificing it; and that, I think, is a fair type of a farmer's monopolies. They are of rare occurrence, and it is not possible to make them lasting.

Nor can any man, however great his talent for controlling other men, or his genius for handling capital, make that use of either in agricultural pursuits that is possible in many others. Agricultural production requires space; its operations will not submit to uniformity of conditions; and while the work itself may be simple enough, the order and manner of its performance must be changed whenever changing conditions require it. The forces against which the manufacturer works are steady in their operation, and can be anticipated and provided for; but the farmer is fighting a foe in ambuscade, and change of front and choice of weapons must sometimes be made at exceeding short notice. Such operations as these cannot be successfully conducted by the general-in-chief seated afar in his headquarters tent. Some one on the ground, either the fighter himself or the squad commander, must direct, and must be unrestricted in his discretion. Hence it comes about that the battle of agricultural labor is fought by individuals or by squads rather than by armies.

There are, of course, farmers who do a large business and farmers who do a small business relatively to each other, but no such concentration of business under a single head is practicable in agriculture as we find in other branches of business. The natural tendency of capital to concentrate and accumulate is largely neutralized by the conditions of agricultural production. It may be asserted, however, and with some reason, that this rule is not without exceptions, and the cases of Glenn of California, and Dalrymple of Dakota, and possibly some others, may be cited as proof that farming may be successfully carried on upon a very large scale. I will very frankly admit that the conditions under which these gentlemen are conducting their operations are much more favorable to success than any which exist with us; and further that they are apparently successful. They work upon broad and unobstructed surfaces, under climatic conditions which are generally uniform and reliable; and they confine themselves mainly to the production of one market crop. It is easy to see that such conditions favor business extensions far more than those under which Eastern farmers work. And yet I am not sure that the success of these parties will be lasting, or the enterprises which they have built up permanent. I remember when a man by the name of Sullivant was described as the "corn king of Illinois." His farm was measured by townships or counties, I hardly remember which; and stories of his prosperity were told which equaled anything which can be said of Glenn or Dalrymple. Within a year or two the newspapers have reported his death in poverty and obscurity, and his burial by the hand of charity.

Somehow or other the forces of disintegration seem always to get to work in these immense farm establishments; they fall to pieces by their own weight and lack of cohesion, and the general verdict is, "It is better that it should be so." It is better because distribution of wealth is better than concentration, unless that concentration is necessary to keep the wheels of progress moving. It is better because many happy and comfortable homes are better than that some be bare of comforts and without the means of happiness in order to furnish an over-supply for one. I yield this point without regret. The conditions of agriculture are adverse to great accumulations of wealth, and those who will be satisfied with nothing short of this will pronounce her compensations inadequate, and turn to something else. Let them go; they are few in number and we can well spare them.

I propose to take one step further in the line of concession. I will concede that the farmer's compensations in money value at market rates are probably less than those of the average mechanic or manufacturer, and almost certainly less than those of the trader or professional man. I do not undertake to prove this. I do not know that the evidence exists to either prove or disprove it. I simply give it as the result of my own observation and as the opinion of many others from within and without the farmer's vocation that, measured in money value at market rates, the farmer gets less for what he gives than he who follows almost any other avocation.

After these concessions is it possible for me to show that farming pays, and pays well? I shall try to do this, and you must decide whether I succeed or fail. What I shall claim for agriculture is hinted at in the limitations of my last concession. Not everything of value can be measured by money. Indeed the things which the common consent of mankind regards as of greatest value are utterly immeasurable by an instrument so crude and so limited in its capacity. It is among such things as these that the farmer must seek his compensation or be resigned to go unpaid, or at best but half paid.

What, then, does agriculture give to compensate for admitted deficiencies in her cash payments? I shall name a few things which seem to me obvious and important, but shall make no pretense of making my list complete or my exposition exhaustive.

To the workman, agriculture offers constant employment. All thoughtful workmen will appreciate this point. Much as they like to get high wages, workmen are reluctant to leave an employer upon whom they can depend for steady work. The situation of a workman out of a job is decidedly unpleasant, for labor is an article which cannot be preserved or accumulated. The day's work which is not sold or invested is lost, and it is better to sell or invest it at a low rate rather than get nothing for it. Dealers in perishable goods are glad to sell low when the choice is between that and no sale at all; but there is no class of goods on earth so thoroughly perishable as unused labor. Now a man with a farm, even if it be a small one, need never be "out of a job." It may not always be a very profitable one, but the man who employs himself will pay his workmen all he can afford, and it would be hardly reasonable to expect more.

Agriculture affords the farmer a sure and satisfactory market for a considerable portion of his productions. I mean of course that portion which is consumed by his own family; and I believe it to be the part of wisdom with every farmer to cultivate this market, to supply as far as possible all its demands, and in brief to put off upon it as great a variety and quantity of first quality goods as he can induce it to take. Surely the supply of one's own wants, from the productions of his own soil, by the labor of his own hands is an employment combining more of the elements of stability and independence than any other which can be named. Be one's ability to labor little or much, it can always be invested at fair rates. Be the demands of one's household great or small, so far as they can be supplied from the farm, no other producer can compete for the trade. I repeat the wish that farmers generally gave more attention to it, took more pains to keep it well supplied, and especial pains that the goods should be of the best quality.

To the small capitalist (and this is the man whose name is legion) agriculture offers opportunity for an investment entirely within his own control, and to which his accumulations may be added as fast as realized. His management may not be always wise, he is of course liable to make mistakes, and must suffer the loss which they involve, but he may at least have the satisfaction of knowing that he isn't paying for other people's mistakes, and in so far as mistakes are a means of education, he is paying for his own schooling and not another's. It is worthy of serious and earnest consideration that the farmer's investment is secure against that large class of risks which flow from the incapacity or dishonesty of others. It is not in the power of any corporation official to steal it or waste it. The farm is burglar proof. The business talents of its owner, though they may not find ample scope, are not without exercise sufficient for healthy development. And then there is always room for his business to grow. No overgrown rival can crush him, no monopoly can choke him. If his talent or training or circumstances give him special advantages in any particular line of production, there is nothing to prevent him from pushing his advantages to the utmost. He can always expand his business to the full extent of his capital and business ability.

Agriculture rewards her followers by surrounding them and their families with the conditions of sound health. I group many items of compensation in this statement, and shall have to separate and classify them for consideration. Sound health is in itself the greatest of earthly blessings, and its loss the greatest of all earthly calamities. The essential conditions for its preservation are,—pure air to breathe, wholesome food to eat, exercise, and rest, sufficient in amount and regular in order. Let us consider for a moment the relation which agriculture as a vocation holds to these matters.

Pure air to breathe; will, then, agriculture insure its followers this? Not always. There are some atmospheric poisons against which the farmer has no especial safeguard and in regard to which he must take his chances with the rest. The malarial trouble which has scourged city and village and rural district alike for the past few years is an instance fresh in the minds of you all, and too fresh perhaps in the bodies of some. But when men crowd together in their work and in their living they create especial danger. They interfere with the wonderful purifying processes by which nature keeps men healthy as long as she can keep them scattered. It sometimes seems as if man himself were a poison factory, and needed to be constantly surrounded by purifying influences and neutralizing processes to keep him from destruction by the waste products of his own machinery. Earth and air supply these conditions, and so long as man keeps himself in contact with the one and bathed in the other, they will in large measure care for him. But when he withdraws himself from the earth, and with wall and roof and close-fitting window shuts out the air, he turns away from two of his best friends, whose kindly offices he too often fails to appreciate. Their caresses may sometimes seem rude, but their friendship is genuine and their helpfulness unfailing.

It would, however, be claiming only half the advantages really due to the out-door life of the farmer to note only its freedom from the vitiated air of the crowded factory, the close office, or the narrow and filthy city street. Sunshine square on one's head and shoulders, wind plump in his face, heat and cold in all degrees short of extremes,—those things are all of them good for a man. They stimulate him, they strengthen him, they give toughness to his fiber, and steadiness to his nerve, and tend to make of him for every good use a more effective organism than he could possibly be without them. These influences the farmer is compelled to encounter. No doubt there are times when he would like to escape them. I've seen such times myself, but they are not the only instances which life affords of failure to recognize one's best friends or to appreciate the acts of truest friendship.

Now in regard to food. I know of course that this general subject is to occupy your attention largely all through this convention, and that its different phases are to be expounded with far greater ability than I can hope to bring to bear upon it, yet its importance is so great that small contributions to its discussion may be helpful, and even some repetition excusable. The list of articles which furnish food for the human race is a very comprehensive one. It includes flesh food of almost every variety. Dairy products hold an important place therein. Every wholesome root is included, and fruit in uncounted varieties, while grain holds a place so prominent that the name of its manufactured product stands as a general term representing all food. The Creator's word to Adam was, "Behold I have given you every herb bearing seed which is upon the face of all the earth, and every tree in the which is the fruit of a tree yielding seed; to you it shall be for meat." And as Noah came out of the ark the blessing of fruitfulness and dominion with which he was endowed included this, "Every moving thing that liveth shall be meat for you; even as the green herb have I given you all things."

And it is a matter of no small importance that man should have a varied bill of fare. One form of food, however palatable at first, at length clogs the stomach and palls upon the tongue. Nature demands a variety, and the demands of a healthful nature are unerring indications of a real need. The needs of the system vary with the work that is required of it, and also with the influences to which it is subjected. Heat and cold, wet and dry, are conditions which we all appreciate, but there are more obscure and subtle influences from within and without which our senses may fail to detect, but which make themselves known by their efforts and by the longing for change which nature voices as she may. Was it ever the lot of any one here to spend a period of several months confined to a diet which excluded fresh fruits and vegetables? I once had an experience of this kind, not severe or much prolonged, but I shall never forget the greedy satisfaction with which I devoured a raw onion, which was the first fresh vegetable I was able to procure. No dainty of the tropics ever tasted half so delicious.

Now to connect this matter with the farmer's rewards. I have to say, that fresh vegetables and fresh fruits are a means of sound health for which no equivalent has ever been found. There are substitutes for them, and they answer their purpose after a fashion, but none of them equal, or can equal in health-giving quality, ripe fruits from the orchard and fresh vegetables from the garden, with the pure crisp flavor of their earthy home still clinging to them. And as I think of the succession of fruits which troop through all the summer and autumn months, marching as they needs must do with locked step to avoid treading upon each other's heels, I feel that no words of mine can fitly speak their praise. As ministers of health, or ministers of pleasure, the fruits of the earth are unrivaled. And there is not one of them that does not lose something of health and pleasure-giving quality by handling, by transportation, and by lapse of time. The perfection of quality which pertains to these articles as they come from garden and orchard, eludes the grip of the most ingenious contrivance for its preservation.

Some of the staple articles of food will bear much handling, transportation for a great distance, storage for a considerable length of time, without serious injury. Thanks to the practical direction given to scientific investigation and inventive genius at the present day, we are constantly learning how to do this in a larger and better way, and have already greatly enlarged the list of articles which can be handled and transported without serious injury. I heartily rejoice at this fact. I would that every toiler of earth, wherever his vocation requires him to live, might be assured of a food supply abundant, varied, and wholesome.

But this is a demand not easily enforced. Money even cannot always command it. Care at a distance from the source of supply cannot insure it, but care at the source of supply can insure it. And this is the farmer's position. He stands at the fountain head, and can help himself before the stream has gathered the inevitable impurities which its lower course exhibits. However small his farm, however humble his home, however limited his means, he may have, in addition to the bread and meat and manufactured dairy products which are within the reach of all, the summer fruits and vegetables in their season, and the fresh, untainted, and unadulterated milk which are not practically within the reach of many of his fellows.

Pure milk is an article of food so important as to demand at least passing notice. Some one has called the domestic cow the foster-mother of the human race, and right well has she earned the distinction. Her contributions to the sustenance of the race, especially during the period of childhood and upon occasions of sickness and feebleness, are of inestimable value. And there is no evil mixed with the good she brings us. Her product, taken fresh and pure, is probably the most perfect form of food within our reach. With here and there an exception, due to disease or constitutional peculiarity, it may be broadly stated that milk as an article of food suits every form and condition of humanity. And yet there is scarcely an article of human food so difficult to handle, transport, and keep without injury. There is nothing the adulteration of which is more easy to accomplish or more difficult to detect or prevent. Exceedingly sensitive is it to atmospheric impurities, and carrying within itself the seeds of change, which if not controlled, will in a few hours send it far on the road to dissolution and decay, it is pre-eminently an article to be taken at the source of supply if we would enjoy its pleasures and appreciate its benefits. I declare I don't believe that many of us realize the worth of a cow, or appreciate the blessings one may bring to the family so fortunate as to possess her. No man who is able to keep one ought to be called poor; she may be made to him and his a source of comfort, health, and happiness which wealth is unable to command.

I must not delay longer upon the relation of agriculture to the food supply, and I turn from it somewhat abruptly to say a few words upon another condition of health which has been already mentioned. It is sufficiency and regularity of exercise and rest. I do not think I shall need to expound at great length the point that agriculture supplies an abundance of exercise, and brings it along with a good degree of regularity. The rising of the sun is a good type and illustration of regularity, but hardly more so than is the farmer's work. No doubt we farmers often think it too regular—would rejoice to see an occasional break in its monotony, and welcome the day that didn't bring a day's work with it. And yet when we think the matter over seriously and candidly, we must, I think, confess that we shouldn't be likely to arrange matters as well in this particular for ourselves as they are arranged for us. We need the pressure of some strong motive, the spur of some stern necessity, to make us do the best thing for ourselves. And we must remember that, if the farmer's days are filled with labor, his nights are sacred to rest. Almost alone among the industries of earth he retains, unbroken and unchanged, the natural order in these matters. If his labors be not excessive, each night repairs and restores the wear and waste of the day, and keeps him, so far as these influences are concerned, in fullness of strength and vigor.

Some other matters of compensation which agriculture offers ought not to pass unnoticed, but must be content with brief mention. The independence of the farmer's life is worth something. Not complete independence, of course, for that is a thing which has no existence; but a large degree of self dependence would be a better expression for that feature of the farmer's vocation to which I wish now to call attention. For employment on the one hand, and for a large measure of his necessary supplies on the other, the farmer depends upon himself. He is thus emancipated from one of the chief causes of servility in modern times. The fear of losing employment and consequent trouble in procuring supplies checks the actions, locks the lips, and stifles the thoughts of thousands. Scarcely any position gives the poor man or the man in moderate circumstances such freedom to think, speak, and act his will as does that of the farmer.

The facilities which agriculture affords for establishing and maintaining a home are not the least of its compensations. It might almost be said that, while other avocations permit homes, agriculture compels them. It is not unfrequently mentioned as an objection to agriculture that it isolates men and families, and shuts them away from their fellows more than is for their good. The opportunities for social amusement and instruction, which abound in cities and villages, are not easily accessible to the farmer, and, in the estimation of some, his loss in consequence is very great. It would be, however, a mistake to suppose the farmer's life necessarily unsocial or entirely destitute of the means of recreation and instruction so much valued by residents of city and village. He can go to the city occasionally, and the village is almost always within reach. It may be something of an undertaking for him to go, and only the greater attractions will draw him out. But when he does go, whether it be to Barnum's circus or Joseph Cook's lecture, some or all of his family are pretty sure to go with him.

Some loss he may experience, but great compensations are set over against it. The home is compacted, and the ties which bind its members together strengthened by surroundings which limit the outside attractions, so that its individual members are but rarely drawn away. Indeed, it is a grave question if the multiplication of the occasions which draw men away from home, though in themselves unobjectionable, is not in this view a great evil. I should think there must be men in cities to whom home could be scarcely more than a boarding-house, and who would not be half as well acquainted with their wives and children as with their associates in business or outside pleasures. The community of interests, cares, and pleasures which forms the ideal home finds nowhere else circumstances so favorable for its growth and development as upon the farm.

I might go much farther in this direction of particularizing the farmer's compensations, but another very important division of the subject remains for consideration, and I must hasten forward. Upon what conditions are these compensations awarded? and what is the reason farmers do not universally enjoy them? for it must be admitted that they do not. Indeed, I have read accounts of life in farm-houses, published by those who had sought temporary homes therein, in quest of the same good things which I have set forth as within the reach of all farmers, and, instead of finding what they sought, they found a life weighted—well nigh crushed—by hurry and unending toil, and narrowed by the exclusion of all means and opportunities for mental culture and the acquisition of knowledge. They found everything else so subordinated to the one idea of saving money that neither time, thought, nor strength could be spared for living wisely or happily. Life was made effective in one, and only one, direction. Food and rest were simply the necessary means of supplying strength with which to earn money, and the least of thought or expenditure that would answer were bestowed upon either.

Such accounts as these stir me both to sadness and indignation. I cannot deny their truth—the evidence supporting them is too strong for that—but they ought not to be true. I don't believe that the proportion of such homes among farmers is very large; but there ought to be none. The farmer who is responsible for the existence of one is a subject for both pity and blame. I hardly know which is the greater, his fault or his mistake. With his fault, however, I have nothing to do; he is not amenable to me; but if I can convince him of his mistake, I may hope that he will at some time and in some degree correct it. The reason generally given why farmers do not have these things so necessary to health, comfort, and happiness is that they cannot afford them. I maintain that no other class of people can so well afford them. No other class of people can buy these things so cheaply. In no other direction can the farmer make the same expenditure yield so large returns. If, instead of trying to make money, which he must do at a tremendous disadvantage, he would try to make comfort, health, and happiness for himself and family, without money, he has great and obvious advantages for doing it. And I believe that the degree of wealth within a farmer's reach may be more surely and easily reached by the indirect than by the direct method. I mean by this that the farmer who strives to produce from his own farm the finest quality and greatest variety of products for home consumption, will be very likely to find among them some one thing that his abilities, his inclinations, and his circumstances combine to enable him to produce with special advantage, and the production of which he can make a leading and profitable industry. It is a great thing for any man to find out what he can do best. This knowledge is the key of success, and when he has found it the gates of brass open wide, and the way lies clear before him. Unless he finds it, he is sure to waste effort and miss opportunity.

Now if the views which I have presented in regard to this matter be correct, it follows inevitably that the farmer who fails to appreciate the real compensation which agriculture offers, who places money first, and the health, comfort, and full development in mind and body of every member of his family anywhere but first, is relinquishing the substance of his reward in what will almost certainly prove a vain attempt to grasp its shadow. With rare exceptions, agriculture does not assure, does not even offer its followers wealth. With rare exceptions, it does offer, and upon reasonable conditions will give to every faithful servant those great and lasting blessings of health, comfort, and independence which wealth sometimes may, but many times cannot purchase. Never, under any circumstances, can wealth purchase better or greater things than these. May not, then, one be justified in calling upon farmers, and especially young farmers, to turn aside from the pursuit of the glittering prize which will almost certainly elude their grasp, and secure the substantial rewards which are within their reach. In something akin to the religious spirit they may be urged to seek first the things of supreme importance, and let wealth come or go as it will. It is as true here as in the higher realm of religious thought that "no man can serve two masters." The man who makes money the supreme object of his desire and effort will be certain to deny himself and family many even of the material comforts of life. He will be very apt to refuse the outlay and care necessary to secure the health of his family, while the incessant practice of the small economies through which alone he can hope to acquire wealth will narrow his mind and belittle his soul until he is incapable of any but the lowest forms of enjoyment. "Ye cannot serve God and mammon."

There is another text I am going to quote, and I have sometimes thought that if I were a preacher I should certainly use it as the basis of a sermon, but I beg you not to be alarmed—I do not propose to preach a sermon now; I shall only give one or two heads and an application. "Is not the life more than meat and the body than raiment?" The nourishment, the development of the body, the breadth and fullness of the life, the welfare of the whole being, these are the objects of highest importance. Food and raiment stand as representatives of the means of obtaining these objects. Money stands behind them as a means to a means. The farmer's position is between the two, and in turning toward money with the absorbing purpose which is necessary to the acquisition of any great amount of it, he turns away from the best and highest things within his reach. Many a farmer who might have comfort, health, independence, and all the satisfaction which a broad, generous, well-developed life is capable of yielding, relinquishes these things for an amount of money which is simply contemptible in comparison. He sells his life for naught.

A few words now as to the conditions upon which agriculture awards these compensations. As I have presented them they exist more as opportunities than as realized possessions. Certainly they are not thrust every Saturday night into a pay envelope and put into the farmer's hands. That is not the form in which agriculture makes its payments. But payment may be made in opportunity as really as in any other form of value, remembering always that an unimproved opportunity is a check never presented to the party who stands ready to honor it, and that in the lapse of time it is very likely to become outlawed. "What thou givest them they gather," says the Psalmist in recounting the lavish bounties of Providence, and of the long list which he recites, agriculture stands as the almoner of most. But they must all be gathered or they will never be ours, and to the task of gathering we must bring thought and care as well as labor. Our forces must not be wasted in a vain attempt to gather what agriculture does not give, but wisely directed to the things that are placed within our reach. Hard work alone is not sufficient for this task.

Hard work. Oh dear! how pitiful the spectacle of a man who can do nothing but hard work. A strange combination of strength and helplessness, like blind Samson in the prison-house, grinding for his enemies and receiving only the smallest pittance necessary to perpetuate his existence. His is the most pathetic figure in the panorama of ages. All avocations use him, none respect him. They place his services lowest in the scale of estimation and award it the lowest rate of compensation. Agriculture does not, cannot do any better by him than do other avocations, for hard labor standing alone is a very low form of service and must receive a correspond-rate of compensation. It is intelligent, well-directed labor that earns and receives the liberal rate.

Now I think there is nothing so much needed in many farmers' lives as a little judicious laziness. It would give them time to think, while now they have only time to work, eat, and sleep, and for both the latter purposes only the least amount possible. It would give them ability to think, which an exhausted physical system cannot give.

Farm problems need to be studied, and the poor body, which is driven every day to the point of physical exhaustion, cannot furnish to the brain the power to study. And so the farmer falls into a rut, and does things because he has done them before, or because some one else has done them, and not because he has studied the problems involved, and is intelligently applying forces and supplying conditions adapted to produce the results at which he aims. Now if a man would secure the priceless blessings of good health for himself and family, he must understand what the requisite conditions are, and then fulfill them.

What I claim for agriculture is that it enables a man to avoid many prolific sources of disease, and to secure the essential conditions of health. It does not, however, release him from the universal obligation of study and care to avail himself of these benefits. If he would have the food supply of his family so varied, abundant, wholesome, and palatable as to conduce in the highest degree to their pleasure and healthfulness, he must pay the price in study, care, and labor. If he would breath pure air he must see that the sources of contamination which exist wherever human life is going on are controlled and neutralized. This involves the same old trio, study, care, and labor. He must know what is necessary to be done, and he must see to it that it is done. For all these things he must pay the price affixed, but I insist that the price is always within the farmer's means, and if invested in this way produces far better results than it possibly could by any other investment. If he would have the independence of his position a weapon of defense and an instrument of progress, and not a mere plaything in a baby's hand, he must make it so by the study and consideration necessary to understand its powers, its duties, and its responsibilities. If he would have the home which, as I have said, he is almost compelled to establish, all that should be expressed by that most precious word that human speech contains, of which heaven is but a paraphrase, and to define which would require a volume rather than a sentence, he must bring to that task the profoundest thought and the tenderest and most comprehensive care of which his nature is capable.

Can care, can thought, can labor be devoted to better uses than these? Can the responsibilities which such opportunities as these lay upon any man be lightly put aside? The opportunity to acquire wealth carries with it its own responsibility, but as you have already seen, in my judgment the farmer is exempt from this. Let him not spend his strength in a vain attempt to reach after it, but turn rather to the better things that are open to him, and live a broad, wholesome, useful, independent life, filled full of varied activities and enjoyments connected, through home and family ties and works of permanent usefulness, with the future as well as the past, looking forward as well as back, out as well as in, up as well as down.

If the compensations of such a life as this do not seem to be sufficient, let him turn to some other pursuit than agriculture. And if, through this imperfect presentation of my theme, any young man is led to estimate the attractions of a farmer's life more justly, and make his own choice more wisely; or any unsatisfied farmer is led to see more in his avocation and to get more out of it, to direct his efforts to better advantage and to secure better results from them, to live a broader, worthier, and happier life—then the objects for which this paper has been written will have been attained, and the labor of its preparation amply repaid.

Adjourned to Friday, December 19th, at 10.30 A. M.

THIRD DAY.

The morning session began at 10.30 o'clock, Mr. **Webb** in the chair.

The first speaker was Prof. N. **Cressy** of Amherst, Mass., who read a paper on "Diseased Meat and its Consequences on our Health and Happiness," which will be found further on.

AFTERNOON SESSION.

The meeting was called to order at 1 o'clock by Vice-President **Hyde**, and Prof. **Brewer** delivered the following lecture:

FERMENTATION IN ITS HOUSEHOLD RELATIONS.

BY PROF. WILLIAM H. BREWER.

We give the name *fermentation* to a peculiar kind of chemical change, in which the decomposition of a compound is caused by the presence of some other substance known as a *ferment*. The word is as old as our language, and the thing it represents has been known ever since Noah made wine, and perhaps longer, but its real nature has been understood for only a few years. Even now only its main features are proved with reasonable certainty. Lying just beyond what is proved there is a wide field belonging to this subject, in which the proof is not yet complete, where we have some considerable evidence, but not enough to establish the principle beyond question. Still outside of this lies another great class of facts which can best be accounted for on the principle of fermentation, where the analogies and inferences are so very strong in that direction that a plausible explanation may be given to otherwise very mysterious processes, but where, after all, we have as yet very little actual proof. Some of these are of so much interest to science, and at the same time of such vast importance to our race, that the whole matter is now receiving much attention and study in one way or another, and is probably the subject of more refined and zealous investigation, than any other department of natural science.

It is a hard subject to make clear in a popular lecture, but

I will use as few technical words and phrases as possible. I will first explain what kind of compounds can be fermented, next the nature of fermentation itself, and then I will give illustrations of the household applications, grouping these into four classes. But I must say in beginning that some parts of the subject which are of great practical interest I must pass by with a mere reference, and others leave out entirely. The subject is too large to be crowded into one lecture.

MINERAL COMPOUNDS.

Chemical compounds are usually grouped into two great classes, the *mineral* (or inorganic) and the *organic* classes. Mineral compounds are usually simpler in their composition and not so easily decomposed. Some of them, like common salt, alum, saltpeter, borax, water, carbonic acid, etc., are found in nature, and can also be made by art, the natural product in nowise differing from the artificial one. Many others, which are not found ready made in nature, can be made by art from the original elements. There are a vast number of mineral compounds, all the elements are found in them, they differ very greatly in their physical and chemical characters, but as a class they can be made by the chemist. He can make (or *compose*) them from their elements, and can unmake (*decompose*) them at his will and pleasure.

ORGANIC COMPOUNDS.

But the compounds of the other great class the chemist cannot make from their elements. He cannot *compose* them, he can only *decompose* them. They are made in nature by (or rather *in*) living plants and animals, or are the result of the decomposition of something that has once formed part of a living thing. They are called *organic* because they are produced in living organisms. Until lately chemists drew a sharp line between these two great classes of compounds; now, however, the line has been broken in a few places, and a few of the so-called organic compounds have been made artificially by chemists. For our present purpose it is more convenient to keep up the old and popular distinction, as the number which have been made entirely by art is very small indeed compared with the vast number which have not, and these only as chemical curiosities, never yet as a commercial or useful product. Some classed by chemists among the organic compounds have been called "mineral" in popular language because derived from fossils, but this need not confuse us—they only grew long ago.

Organic compounds as originally formed are usually of more complex chemical composition than the mineral ones, and so soon as the plant or animal which produced them is dead they readily decompose into some simpler compound, and by further decomposition these in turn change into still simpler ones, until at last they are resolved into those mineral compounds which the original plant lived on in the soil, water, and air.

Organic compounds are essentially composed of four elements, carbon, hydrogen, oxygen, and nitrogen, sometimes with the addition of another, as sulphur or phosphorus. As a rule, those which contain much nitrogen decompose easier, and stink badly during their natural decay, or as we say, they *putrefy*.

FERMENTATION.

Fermentation, as has been stated, is a kind of decomposition which must be started by a *ferment*. There are *two* classes of ferments, known respectively as the *living* and the *soluble* ferments.

The living ferments are of so much more importance in this connection than the soluble ones that I will devote this lecture entirely to them, and will use first the most common illustration.

You are familiar with sugar. It is formed in the sap of many plants, such as sugar-cane, sorghum, maple, etc., it is in the juice of our common fruits, giving them their sweetness. There are several kinds of sugar; some are sweeter than others, some can be crystalized, others not, and they differ also in other properties. Some, like the sugar of milk, are formed in animals, but I will pass them by now. In the plants where it is formed it is always dissolved in the sap along with other organic substances. If it be purified, as is done more or less perfectly in the manufacture of sugar, it will then keep pure for an unlimited time,—that is, it will not decompose of itself. It may be dissolved in water, and the solution, if kept pure, does not decompose, and may be kept indefinitely—for ever, as far as I know.

Suppose, however, that we add a little yeast to it. Or, better, as a more familiar illustration, add a little yeast to the sweet juice of apples or grapes, and keep it at the right temperature, not too cold nor too warm. Soon a disturbance begins, the liquid begins to *work*, as we say, and becomes more turbid, fine bubbles of gas are formed, there is a slight rise of temperature in it. If we let this go on until it runs its course, we find after a time that the disturbance ceases, no more gas is given off, the temperature falls to that of the surrounding air, the turbidness grows less, a sediment falls to the bottom, and in time the liquid again becomes entirely clear. We say that it has *worked* itself clear.

It is, however, no longer a solution of sugar; it has no sugar in it; it has lost all its sweetness and is sour—it is vinegar. If we had stopped its working when but half done, and at just the right time, we would have had neither sweet sugar nor sour vinegar, but alcohol. All this has been done by the action of the yeast.

YEAST.

When yeast is seen with the microscope it is found to consist of countless multitudes of *cells*. This fact could never be known until microscopes were invented, because they are too small to be seen by the naked eye, and the discovery was made in the very earliest days of microscopy, by the Dutch microscopist *Leuwenhoeck*, in 1680. A century later, in 1787, an Italian, *Fabroni*, stated that yeast was a *living* organism, having both a vegetable and an animal nature. It is, however, within the last forty or fifty years that the true nature of yeast and similar ferments has been demonstrated, and much less time since all the more important facts now known have been demonstrated. I will not attempt any details of the history of this interesting question; I will merely say that all such ferments, of which yeast is the type, are *plants*, very low in the scale of being and very simple in their structure, yet living, growing plants, having their own laws of growth, of life, and death. By botanists they are classed with the *fungi*.

All living beings are made of cells, each cell too small to be seen by the naked eye. The living cell is a little closed sac, filled with a liquid. There are two or more coats or walls to a cell; the outer is thicker and coarser, the inner thinner and more delicate,—the two coats adhering closely together, like the fine lining to a coarser bag. No hole can be found through the coats of a cell, but water passes in and out freely. It is porous, although no pore can be found with the most powerful microscope. All growth, whether in animals or plants, is by the division and growth of cells. Every plant and every animal (if it come from a spore or seed or egg) probably begins its life as a single cell; it develops and grows by the cells dividing and multiplying, and during this growth various substances which are brought in contact with these living cells are changed in their composition by it. The process of growth depends upon this, and in some way all the organic compounds we find in either plants or animals are composed or made in this way. The changes go on in the substances that are dissolved in the juices of the plant, and thus are brought in contact with the walls of the living cells.

I have said that yeast is composed of vegetable cells. Now it is found that during such fermentation as I have described (as when cider works), these living yeast cells multiply and grow in the fermenting liquid, and they continue to grow and multiply as long as the change is going on. If we kill these living and growing yeast plants (for plants they are) we stop the fermentation. The chemical changes go on only when the cells are living and growing. You all know that if we *boil* yeast it is no longer good for anything. If we examine yeast with a microscope, just after boiling, we find that the cells are killed, they are shriveled, often collapsed; sometimes the coats are partly separated from each other, and the material has all the character of a dead substance rather than a living one. It easily decays, and smells badly during the process. Many poisons act in the same way; they *kill* the living cells, and when their life is gone they will no longer induce fermentation.

There was a long and bitter controversy among scientists regarding the nature of the chemical changes during fermentation, whether the living cells caused the chemical change, or the chemical change caused the cells. This, in the case of yeast, was settled beyond question less than a score of years ago; and, indeed, here and there an old man is still skeptical. Without entering into this controversy it is enough to say that no eminent scientific man now denies the fact that the living and growing cells are the *cause*, not the result of the chemical decomposition that takes place in ordinary fermentation; the debatable ground is now pushed further along, and the question now is, whether *any* organic compound found in the animal or plant would decay at common temperatures except by fermentation or a process analogous to it.

There are many species of living ferments, and each species produces its own kind of fermentation. One species, in the working of cider, or beer-wort, or whiskey-mash, produces alcohol, and consequently we call it the *alcoholic* ferment. Another, in souring milk, produces lactic acid, the principle of sour milk, and we call that the *lactic* ferment, and so on to a great number which have been studied by chemists and microscopists, and descriptions and pictures of them are to be found in the books relating to this subject.

Where living beings are complicated in their structure, and have many organs, many different chemical compounds are elaborated during their growth by their various cells. In a corn-plant, with its roots, and stalk, and leaves, and tassel, and silk, and ear, and in the different parts of each organ, in the whole plant there are many chemical substances produced, such as woody-fiber, and starch, and sugar, and oil, and albuminoids, etc. But where the plant is very simple in its organization, like one of these ferment-plants, the chemical work is correspondingly simpler, and but few compounds are produced. There is this difference, however,—the higher organism, like the corn-plant, forms its products from the mineral and decaying matter it finds in the soil, air, and water. It is a process of building up from the simpler to the more complex. Not so the ferment-plant. It does not build up, it only tears down what has already been built up by the higher organisms. Moreover, it changes vastly more than it uses. A little yeast will change all the sugar in a whole barrel of sweet cider to vinegar. The higher organisms are builders, the ferments are destroyers.

Whenever we have a fermentable liquid exposed to the free air fermentation soon starts—*apparently* spontaneously,—that is, without our adding any yeast or ferment.

The explanation is that the ferment-organisms are *very* small and very abundant. Some of them (and possibly all) have two ways of propagation. The usual way is by cell-division,—that is, an old cell divides and makes two or more new ones, and these again divide, and so on. The other method is by fruiting. The fruit or seed of any fungus is called a *spore;* botanists do not call it a *seed* because its structure is very unlike that of a seed, but it plays the same part in nature, producing a new plant. Spores are always *very* minute, very much smaller than any seed. The adult cells of the yeast-plant are but $\frac{1}{3200}$ to $\frac{1}{2800}$ of an inch in size, and the spores are correspondingly more minute. The cells of the lactic ferment (which sours milk) are only $\frac{1}{10000}$ of an inch; of the butyric ferment (which makes butter rancid), $\frac{1}{14850}$; and others, particularly the septic ferments, still smaller.

We have strong reasons for believing that some spores are entirely too small to be seen by the most powerful microscopes ever made, and yet capable of germinating when the conditions are right.

Of late years many careful observations have been made on the nature of the fine dust which floats in the air, and it is proved that many spores are floating about, and even the dried cells themselves, dry but not dead, ready to start fermentation if they fall where they can grow. Dust, with invisible ferments, or their spores, is everywhere in the open air; the particles fall on the fruits, get into their juices when it is expressed, and start the fermentation, which once started then goes on of itself. It has been claimed that it constitutes in part the delicate "bloom" on grapes and certain other ripe fruits.

The various ferments differ in size, in shape, in organization, and produce different chemical results.

All plants require oxygen for their growth. The higher plants must have it free, from the air, but ferments may get it in other ways. Thus, when sugar is the fermenting substance, the yeast-plant needs some free air to start with, but then it will go on without air, it will even grow in an atmosphere of carbonic acid. The sugar itself contains oxygen, and during the fermentation the yeast-plant gets its oxygen from that. It may be that this is the actual cause of the decomposition.

But this is no place to discuss the theories as to the way the chemical change comes about. Suffice it to say that decomposition does go on during the growth of the ferment, and that fermentation in some form is the common way in which organic substances begin their decay in nature.

I have been thus lengthy in my introduction, because most of the household applications are only made certain in practice when we have a reasonably fair understanding of the principles involved. For example, canning fruit was never made a success in household practice until the true nature of fermentation had been demonstrated.

I said in beginning that I would notice four phases or classes of household applications. The first is of

FERMENTATIONS WHICH ARE WANTED.

We employ fermentation most in the raising of bread, in making fermented drinks, in making vinegar, and in a few cases in preparing foods.

The most common of these is the raising of bread before baking. Our starchy foods may be grouped into two great classes, the *breads* and the *puddings*, or the light and the heavy. The light ones are raised in five ways, the first two by fermentation, the other three by other means.

The first is where *leaven* is the ferment. This is the oldest method, but in this country is rarely used in families, except as I will refer to again,

The second is where *yeast* in some form is the ferment. This is the usual way in families and in bakeries.

The third method is where some carbonate is used to furnish carbonic acid, bi-carbonate of soda now-a-days, bi-carbonate of potash (saleratus) formerly. Some acid or substance like cream of tartar is used to liberate the carbonic acid. It may be so mixed as to form a "baking powder," or it may be used with sour milk or some other acid.

The fourth method is by incorporating a gas under pressure. This requires much machinery, and produces the *ærated bread*, so called. It is only done by bakers, and never in families.

The fifth method is where the mixing is done very cold, and where the liquids used are very cold, and consequently contain much gas or air dissolved, which is liberated by the heat of baking. It is claimed by some housewives that this is the method for the nicest of flakey piecrust and for certain cakes in which milk is used.

But as no fermentation is involved in either of the last three methods, we will dismiss them and return to the first.

I have already spoken of fermentation which is *apparently* spontaneous, when fermentable substances are exposed for a time to the free air. If dough is mixed and allowed to stand, in a longer or shorter time it begins to ferment, and after an uncertain length of time sours without the use of yeast. This sour dough is *leaven*, which added to fresh dough starts that into fermentation; and this was the method used from the earliest time down to the last, and even extensively into the present century. It is less manageable than yeast, and has therefore fallen into disuse. Families sometimes resort to it still in back settlements where there is difficulty in getting yeast. Some years ago, when in the mountains and away from civilization, my cook in camp used this method with reasonable success, and I have seen it used by others in similar circumstances. I remember, when a very small lad, it was used in some families in a pioneer population, but now the method has so completely passed away, in making bread, that many of the younger generation have never seen it. The principle, however, is extensively applied in the country for raising buckwheat cakes. The batter left over from the morning's baking is set by in a cool place until evening, when fresh flour is stirred in, the whole set in a place of the right warmth; the old batter is the leaven to the new, and in the morning all is light. This works well with care, going on for months, and *connoisseurs* of this delicious breakfast item claim that buckwheat cakes raised in this way are the best, are the most acceptable both to the palate and the eye.

The most common bread-ferment, however, is *yeast* in some form. In brewing, when the sweet infusion of malt (called *wort*) ferments, a frothy substance rises to the top, which is yeast. One way of "cleansing" beer is to fill casks with the fermenting wort, and let the frothy yeast work itself out the bung. Formerly this was done in tubs or vats, and the yeast ran out over the top. Hence the old English name of *emptyings*, a name still heard in rural districts (usually shortened to "*emptings*") for the ferment of bread. It is known to science as the *alcoholic ferment*. It is the same thing which produces the alcohol of cider and wine, and also of all our spirituous liquors. I have already described it as a fungous plant. It may be dried without losing its life; and dried yeast in some form is now a common article of sale, and is prepared in large quantities. In domestic practice, this same yeast-fungus dried along with Indian meal and an infusion of hops, prepared in a certain way, known under the old-fashioned name of "turnpike cakes," or simply "turnpikes," is extensively used in country homes, and many a successful housewife still thinks them superior to any of the more modern forms of yeast found in the stores.

For the highest success in raising bread, many precautions have to be taken to get the best results. As so many of the conditions are variable, particularly that of warmth, the successful baking of bread is more of an art than a science. I see by the smile this provokes among my lady hearers that they think so too, so I will drop this part, lest I be caught tripping. I will only say that different flours act very differently in the rapidity and ease with which they go into fermentation. Some bakers are in the habit of mixing the different sorts so as to get the lightest bread, and the extensive use of potatoes in setting the dough has reference more to its relations to the fermentation than to anything else.

We must keep in mind that the real action of yeast is to change sugar into alcohol, and this in turn into vinegar. In raising dough and in making alcohol, the process must be stopped at the right time, and this is done by *heat*, which kills the ferment-fungus and stops its chemical work. If it goes too far the alcohol becomes vinegar, the bread or the beer sours. That alcohol is formed during the raising of the dough, and expelled by the baking, is proved beyond any doubt. Several patents have been granted for processes for saving this alcohol, and one company in London is said to have spent a hundred thousand dollars in trying to save this alcohol for commerce. It succeeded in saving alcohol in large quantities, but the ovens constructed so as to save it did not bake the bread so nicely. The people preferred bread baked in the old-fashioned way, and so the process was pecuniarily a failure.

Although the special action of this ferment is to produce alcohol from sugar, other changes go on with it and incidental to it, in the raising of dough, working of cider,—and indeed in all ordinary fermentation. In the dough a part of the starch is changed into a soluble form before any of it is changed to sugar, and other changes go on in the fermenting mass. It is commonly believed that fermented breads are more digestible than unfermented ones, and it seems to me very probable that this is so. Digestion itself is analogous to fermentation. Certain substances found in the juices of the stomach and the saliva are classed among the "*soluble ferments*," and, indeed, are usually taken as their types. *Sauer kraut*, which is a partly fermented substance, is more easily digested than the "slaw" of which it is made. Even when the fermentation is carried on to sourness, many persons claim for it more wholesome properties. Sour cider, sour wine require a cultivated taste to like them, but they are probably more wholesome as a whole than the sweeter article. Some of the peasantry of the old world who eat coarse sour bread claim for it high nutritive value, but I am content to follow my own education, and I prefer bread that is not sour.

As we are to have a paper on bread this evening, I will not follow this any further, but pass next to vinegar, where our subject has naturally brought us. The sour principle of vinegar is known to chemists as *acetic acid.* Vinegar is made by fermenting some liquid that contains either some kind of sugar or else alcohol. With us the most common basis is cider, and this, to my taste, makes the best vinegar, although those most used to wine vinegar prefer that. To make good vinegar, start with good "*mother*," which is the familiar name of the ferment. The material must be kept moderately warm. After the fermentation has practically ceased, and the liquid clears, it still improves in quality for a time,—it *ripens*, as we say. For family purposes an old wine-cask may be used, to which cider that has passed its first stage of fermentation may be added occasionally with satisfactory results. But for a good article we must not use a musty barrel, or the wrong ferment may work. Before I close I will have to tell you of other ferments which produce other substances. Thus far I have dwelt on the production of alcohol and vinegar. To illustrate what I mean I have brought with me two bottles. I will pass them both to the audience and let them be passed about, as they illustrate just what I wish to explain. The first bottle is partly filled with vinegar drawn from my own barrel of cider vinegar at home. You will all pronounce it of excellent quality, strong, pungent, aromatic, just the vinegar for nice pickles.

Eight months ago I took some of the "*mother*" from that barrel, washed it with clean water, then put it in this fruit-jar in a solution of clean white sugar in water. Now this, you would say, ought to have made nice vinegar. But besides the "mother" as a ferment, I added some fungus scraped from a rotten maple stump near my door,—not more than enough to make a mass half as large as a pea. But it contained fungi that has produced other products than vinegar. I have watched the process from week to week, sometimes using my microscope, and now I pass it to you to show you how easily a vinegar may be spoiled. Along with the pungent odor of the vinegar is a peculiarly penetrating, stinking odor, disgustingly so, which lingers in the nostrils long after being inhaled. The wrong ferment has been at work. This is practically what spoils many a vinegar barrel—something is put in which contains some putrid ferment, and then the mischief grows. I don't know of any way to correct this but to begin anew, with a better barrel and fresh material. We have a similar thing with beer, which I will speak of here, as it illustrates the same principle. The celebrated French chemist, Pasteur, who has made ferments his life-long study, investigated the causes why some batches of beer turned out badly, and he found that it was produced by the wrong ferments getting in the wort and producing chemical changes which made the beer bad.

Now to return to vinegar. It is an important preservative, although it has been produced by a form of decay. There are many vinegars in market. In the old world much is made from wine. Some of the finest English pickles are put up in malt vinegar, where the infusion of malt is not made into beer but into vinegar, and an excellent vinegar it is. I once lived in a place where cider was scarce and dear, but whiskey abundant and cheap (it was before the war), and a single establishment made yearly many thousands of barrels of vinegar from diluted whiskey, fermented in large vats kept carefully at the right temperature. And so I might enumerate many sources. Those who live in cities and buy their vinegar, little know what is the basis of the vinegar they buy. I once knew a man who had a bar-room next his grocery, and the washings of his glasses, with the tinge of whiskey or rum, and the sugar left in the bottom, furnished the material to be worked into "pure wine vinegar" for his customers. These various sources give vinegars of different flavors, but the acid in all is the same. Vinegar is often adulterated with sulphuric acid (oil of vitriol), but this has nothing to do with fermentation.

Various summer drinks, such as root beer and small beer, are fermented with this same ferment, and all contain a little alcohol, but not enough to disturb the conscience or head of the most enthusiastic temperance advocate, although often enough to point the argument in the pettifogger's plea when defending some illegal sale of a stronger article.

Fermentation is often employed in the preparation of cattle foods of one kind and another. Grain, or cut hay, or other article is wet and allowed to partially ferment, and there is a wide-spread belief that such foods are more fattening, and I have known some examples where this seemed to be the case.

The next class of household applications is of

FERMENTATION WHICH IS NOT WANTED,

And is therefore to be prevented if possible. The most common application is in the canning of foods, but it also applies to other methods of preservation. I have said that some form of fermentation is the usual method by which the various products of animal and vegetable growth begin to decay. I have also said that anything that kills a living ferment immediately stops the chemical change it produces. A high heat is destructive to life. There are certain seeds, spores, and germs which can for a short time withstand the heat of boiling water (212° Fahr.), and still germinate, but they are relatively very few, and, so far as we know, no animal or plant during its adult or growing period can be actually boiled and still live.

Now, the whole art of canning foods is founded on the theory developed by science that fruits, meats, etc., will not decay unless some living ferment starts the process, and that all living ferments are killed by being thoroughly boiled. You know the process. It is essentially to thoroughly boil the material to be canned, to kill any ferment that may already be in it, put it into a jar or can that is heated hot enough to kill any germs sticking to it, and seal it up tightly while still hot, before any others can get in. If well done, the material will keep for years. If some germs lurk inside not killed, they will do their mischief, and the stuff begins to "work." If it be fruit or vegetables, we can boil again and correct the evil; but if it be an animal substance, as fish or flesh, it cannot be saved. The ferments of flesh are what are called *septic* ferments, to be noticed later, and if the can of meat or fish begins to ferment, its flavor is spoiled before the change is discovered, and there are cases where both fish and meats have been rendered in a measure poisonous, producing sickness, because of such change going on after the can was sealed.

The success of canning, so far as preservation is concerned, depends entirely on effectually killing all the ferment-germs that are in the mass, or the vessel, and protecting the material from others getting in. We may boil a mass on the outside without the inside being thoroughly heated to the same temperature, if the material is not very fluid, just as we may have a piece of meat underdone in the inside although well browned on the outside. To the more effectually heat the material after being put into the cans, many devices have been resorted to. Some persons use *brine* instead of fresh water to set the jars or cans in, because brine can be made hotter than water. Some canning establishments have used a solution of *chloride of calcium* for the same purpose, which boils at a still higher temperature. I said that the sugar-ferments need some free oxygen to start the fermentation. The reason why it is well to have the can as full as possible before sealing, is to have as little air there as possible to aid the ferment in starting its growth.

The process of canning was a direct contribution of science to household comforts, and was not invented until the theory of living ferments was reasonably well demonstrated, although many applications of the same principle were used earlier.

I rather wonder that it should not have been invented and come in common use before it did. In the earliest days of my teaching chemistry, and long before my own school-days entirely ceased, while employed in a small agricultural school in Western New York, in 1851, to practically demonstrate the principle and show how chemistry could be applied to household uses, I "canned" several gallons of stewed tomatoes, using glass-stoppered bottles from the laboratory. It was a great success, and other families then began to use the process. So soon as the scientific principle was well demonstrated and known, the use sprung up in many places independently, and now the magnitude of the business is known only to those who have had occasion to look into the statistics of it.

Fermentation takes place easier in dilute solutions than in concentrated ones. The old process of making "preserves" and "sweetmeats" was founded on this; great quantities of sugar were added, and fermentation did not take place readily in the viscous mass. But even then accidents would happen, and the dainty morsel often would "work," to the great disturbance of the housewife, setting her into a mental fermentation also.

The boiling of new sweet cider and concentrating it to prevent its working is another illustration familiar to most farmers.

Sometimes it is desirable to check fermentation after it has begun. In bread we do it by baking; in fluids it may be done by boiling; but in wine or cider this would injure the quality, so various other means are resorted to. The fumes of burning sulphur, the use of *sulphites* and *hyposulphites* are often recommended, and are successful.

The third kind of "household relations of fermentation" is

THE SOURING OF MILK,

Which is a process of fermentation, and is due to the action of a special kind of fermentation, the ferment-fungus being of another species and producing *lactic* acid, as yeast produced *acetic* acid. If this ferment is prevented from growing, milk may be kept sweet a long time—I have no idea *how* long. Perfectly pure milk put into glass bottles which have been strongly heated will keep a length of time that seems incredible. All the means I have spoken of as preventing fermentation apply to the preservation of milk. Boiling, concentration, keeping in closed cans, and keeping cool are the most common methods. In condensed milk the same principle is applied that is used in condensing sweet cider. Many efforts have been made to preserve milk by the use of some chemical, and with some hope of success, but it is yet a question whether anything can be found which will kill a ferment-fungus in milk and yet be perfectly wholesome for man. The theory of ferments explains perfectly why dairies should be kept clean, why milk sours so much easier where the utmost cleanliness is not maintained, why the vessels must be so carefully scalded, and why milk should not be spilled about and allowed to remain.

The fourth class is known as the

SEPTIC FERMENTS.

They are the agents which induce putrefaction in substances containing more nitrogen. It has lately been found that putrefaction is accompanied with the development of ferments which are much more minute than those I have heretofore been speaking of, and about which there is more uncertainty. It is a question if even the most putrescible animal or vegetable substance would decay at all, at ordinary temperatures, without their aid. It seems to me to be pretty well demonstrated that if we prevent their growth there will be no putrefaction. Very many experiments have been made in late years pertaining to this subject, and just now no scientific subject seems of more importance to our race.

Among the more interesting and easily understood experiments are those of Professor Tyndall, which I will use for illustration.

There is always dust floating in the air, as we see when a beam of sunshine enters a dark room through a hole or crack. It is known that in this floating dust are the germs of many kinds of ferments, and particularly septic ferments. Prof. Tyndall prepared a number of boxes, a foot or two square, with small plate-glass windows in three sides. A number of holes were bored through the bottom, through which open-mouthed glass test-tubes were thrust, their open ends within the box, their closed ends projecting below the bottom. These were tightly cemented in place. In the top of the box was another hole, over which was tightly fastened a thick but pliable sheet of india rubber. Through a slit in this was passed the long tube-like stem of a small glass funnel, which could reach the mouth of the test-tubes. There was a small vent by which the air could enter or leave the box with changes of temperature or of barometer, the air being filtered through cotton moistened in glycerine to remove any floating particles there might be in the air. The whole inside of the box is smeared with glycerine.

When all ready and in a dark room, a beam of very strong light is sent through the box from an electric lamp, and floating dust or motes may be seen in the path of the beam of light. If now the box remain quiet for a few days or weeks, the dust all falls to the bottom or sticks to the sides of the box, caught by the glycerine; and when a beam of light is sent through the windows in the box from the lamp, all is dark, the track of the beam cannot be seen; and in that way he found out when there were no longer any motes, and hence no ferment-germs floating in the air and liable to fall into anything put in them.

Now, by means of the long funnel passing through the rubber in the top of the box various putrescible liquids were introduced into the test-tubes; into one beef-juice, into another the juice of fish, and so on; the juice of various kinds of fish, flesh, fowl, infusions of vegetables as well as animals, mixtures of the infusion of turnips and cheese, cucumber juice, urine—in fact, the most putrescible things he could think of, to the number of some hundreds in all. Then the tubes were lowered into hot oil and all the liquids in them boiled to kill any ferment-germs they may have contained. They had all been very carefully filtered before being put in, so that they were perfectly clear. The whole were then kept in a warm room.

Now bear in mind the circumstances they are in. They are in perfectly free contact with the air inside the box, but this is pure air, perfectly free from motes and dust. If it is the contact with air alone that causes putridity, then they ought to decay in the box as well as if outside. But none of them do decay. Weeks, months, and in some cases even years have passed, and the liquids remain as clear and sweet as the day they were put in, even the most putrescible of them. They may be watched, both through the tubes themselves and through the windows in the sides of the box. But once open one of the windows of the side of the box and let the common air of the room enter with its dust and motes, even for a moment, or but touch the clear liquid with the point of a needle which has touched a putrescing substance, and then soon the fluids in the tubes begin to grow cloudy and turbid, a pellicle forms on the surface, the microscope shows now that there are myriads of ferment-organisms, the fluid rapidly goes into putrescence, sometimes a mould grows over the surface, and in due time the liquid is resolved into a rotten, stinking mass.

This is but a sample of a great number of experiments which appear to prove that ordinary putrefaction is but a form of fermentation, caused by living ferments, of the class known as *septic* ferments. The canning of meats, fish, lobsters, etc., is a practical confirmation of this theory, and so far as I know, all methods of "*disinfection*" are also in accordance with it.

Popular language often confounds three distinct things: *Antiseptics* prevent decay; *disinfectants* stop decay already begun, and kill the germs which may induce further chemical decomposition; *deodorizers* clear away bad smells, whatever may be their origin, although sometimes the same chemical may produce all these effects.

To clear up the foul smells and disinfect decaying filth about the house, copperas (green vitriol or sulphate of iron) dissolved in water, in about the proportion of a pound of copperas to a gallon of water, is one of the safest and most convenient disinfectants to use about the house where there is no harm of staining. This is especially good for purifying privies, cess-pools, and other foul-smelling places. Carbolic acid is often used, but the sort which is most commonly sold in market smells badly of itself. Chloride of lime and burning sulphur are often used for fumigating, either to remove bad smells or to disinfect premises and rooms where there have been infectious diseases.

MOLDS.

Molds are very like ferments, both in their botanical character and chemical effects. The principal difference is this, that molds get the oxygen for their growth from the air, while ferments get it by decomposing the compound they live in. Some molds, if deprived of air, become true ferments, both in the way they multiply and the decompositions they produce. All molds produce decomposition, and most of you are familiar with many illustrations of where molds spoil the substances they grow on. The spoiling of ink, bread—in fact, almost anything about the house which molds, are examples too familiar to you all to need enlarging upon.

Anything which prevents the growth of mold preserves the substances usually affected by them. Oil of cloves, creosote, carbolic acid, corrosive sublimate, and various other solutions are used to preserve paste, ink, etc., and they act by preventing the growth of molds or ferments. Molds and ferments require two things, something to live on, and moisture. The first we are very apt to have somewhere about the house; the second we should not have about the house if we would live in health.

If a cellar is too damp, it will be moldy, and should be dried in some way. If it is reasonably dry and still molds much, it is a sign that it is badly infected with germs, and has most probably some unwholesome condition which has escaped notice. Therefore cleanse it thoroughly, be sure it is dry, ventilated, and keep well whitewashed. Fumigating with burning sulphur often helps a moldy cellar. Burn a pound or two of sulphur in a kettle of burning coals.*

I have reached the limit of my hour, yet I will take a few minutes more to speak of another class of phenomena, which most probably belongs to this subject, but where the theory has not yet been proved. I refer to what is best known in common language as

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* I will mention here, although it has no relation to fermentation, that the fumes of burning sulphur is perhaps the most convenient and effective means of getting rid of the odor of skunks, sometimes so very annoying about the farmer's premises.

THE GERM THEORY OF DISEASE.

There is a large class of diseases which present phenomena so like those of fermentation that the resemblance was noticed even by the ancients, and from this long-observed resemblance they are called *Zymotic* diseases, a name derived from the old Greek word meaning fermentation. Some of them, like small-pox, plague, typhus and scarlet fever, are contagious. Some are communicated only by inoculation, as we see in ordinary vaccination. Others, like typhoid fever and cholera, are not contagious, but may be communicated through drinking-water or other substances taken into the stomach. Still others, like yellow fever, are not communicated by means of drinking-water, and are not contagious, and yet they do spread by some form of infection, the precise character of which is as yet undetermined. Some diseases of this class, like the chicken-pox, are of little importance; but others, like the cholera, yellow fever, plague, and small-pox, sometimes become the most dreadful pestilences which afflict our race. And not our race alone, for the brute creation has its pestilences and plagues also, which are just as destructive, just as deadly, and which belong to this same class of diseases.

In the few minutes I have left, I can glance at only some of the facts and reasons we have for believing that these diseases are due to a kind of fermentation.

In the first place, each must have a specific something to start it. We do not have the measles, nor the cholera, nor small-pox, without being infected with something which comes from beyond ourselves. The disease does not start in us without the infection. As in fermentation, a something is required to start the action, but when once started, it then goes on without any further addition of this infecting substance.

In the second place, just as fermentation runs a definite course and then stops, so these diseases do. First each has a quiescent stage, then later a disturbance with a rise of temperature (all these diseases are accompanied with fever in their active stages), then a decline. They run a definite course and last for a somewhat definite period. A man may have the rheumatism or the dyspepsia for forty years, but he cannot have the measles, nor the small-pox, nor typhoid fever for even one year. They run their course (unless the victim dies) and then cease. Moreover, with many of them a man has the disease but once, just as a barrel of cider ferments but once.

In the third place, the chemical effects in the system are very like those of fermentation. A man has the cholera and a rapid chemical change goes on in his blood and juices; they lose their usual characters at a fearfully rapid rate, and they are cast forth from the system in a state of active decay entirely unlike any of the dejections in health. And something of the kind takes place in all these diseases—something is attacked, and some definite and specific change is produced. The chemical change may show itself in the skin as in small-pox, or in the intestines as in typhoid, each disease having its own special form of destruction just as each ferment produces its own special decay.

In the fourth place, the chemical characters of the virus of contagion are like those of a living organism, but entirely unlike those of a mere chemical poison. For example, compare it with white arsenic. A certain dose of arsenic is required to kill, say two or three grains. When the poison is swallowed it begins its work immediately, and so soon as enough is absorbed into the system the victim dies; it may be in a few minutes if the absorption has been rapid enough, or it may be after some days, but in either case with the symptoms of a disease. But this disease cannot be communicated to any one else unless the arsenic is extracted from the dead body, and then we would find no fresh poison produced, no more arsenic than we began with. Moreover, with poisons, as a rule, the larger the dose the more speedy its action, if it be retained. And so also of strychnine, and prussic acid, and the many "*poisons*" known to chemists. Now all this is very unlike the virus of contagion. A minute speck of small-pox virus, what we could hold on the point of a needle, is introduced by a scratch into the blood of a man who has never had the disease. It does not show its effects at once, but for a time it is apparently dormant, as a seed seems to be in the ground before it sprouts, or an egg is before it hatches. After a somewhat definite time the disease appears and runs its course, during which large quantities of fresh poison are produced with which many more persons can be inoculated, and these in turn produce still more of the virus, until in a comparatively short time there would be enough to infect the whole human race. The spread of typhoid fever, cholera, the plague, and all the others of this class of diseases shows essentially the same class of facts. Now all this is entirely unlike any chemical poison known, but it is very like a living ferment, growing and multiplying in the juices and fluids of the creatures infected, living on the organic substances they contain, changing the characters upon which their health depends, bringing disorganization, decay, and destruction of the tissues, and, it may be, death.

In the fifth place, the physical character of the infection and its relations to heat are more like those of a living ferment than a dead chemical poison. A great many interesting and instructive experiments have been made on vaccine, the virus of small-pox, sheep-pox, glanders, and on the virus of various other contagious diseases.

In all cases tried, the virus is killed by boiling, just as the living ferments are, but they usually stand a much greater degree of cold than of heat. They also lose their infective properties with age, and this is hastened by free exposure to the air. The virus of different diseases varies greatly in this last respect, but as a rule, the same treatment which will prolong the vitality of seeds and of living ferments, will also prolong the vitality of the virus of contagion.

The virus of the sheep-pox (and of other poxes, so far as examined,) is produced in the "matter" or *pus* of the sores or *pustules* peculiar to these diseases. This *pus* consists of an albuminous liquid having very small particles diffused through it. The two can be separated from each other, and then the fluid without the particles will not produce the disease, but the particles without the fluid will. That is, the infective principle is in the particles and not in the liquid, just as in wort, vinegar, etc., the "infection" is in the yeast-cells and not in the liquid in which they are suspended. When the particles from sheep-pox (or vaccine) are used to innoculate a new subject, the disease is communicated, and fresh particles are formed in the new victim, just as fresh yeast-cells are produced in a new barrel of cider. But these particles in vaccine and in sheep-pox, etc., are so very small and so nearly transparent, that the best microscopes tell us little about their physical characters more than their mere existence. It does not prove that they are specific living cells.

In the sixth place, the most successful methods for the prevention and control of zymotic diseases are conformable with the theory that the infection by means of which they spread is a *living* infection, call it a germ, or spore, or cell, or ferment, or what you will. The disinfectants and conditions which experience has shown to be the most efficient in staying contagion or purifying places from its effects are the very things which we know effectually destroy the life of the actual ferments with which we are acquainted.

In the seventh place, it is abundantly proved that some of these very diseases are produced by living organisms which belong to the class of septic ferments. They have been very carefully studied, the history and development of the living ferments which produce them have been traced, and figures of them may be seen in various works on sanitary science. The relapsing fever in man, a very contagious disease in some countries of the old world, is now known to be due to such a cause, and several other diseases of man might be cited. The "pig-typhoid" in swine is another case, the "febrine" or silk-worm disease is another, and a very considerable list might be prepared where the proof is complete and convincing. In some cases, the infection is a true ferment which can be cultivated in certain animal fluids, outside of the animal body, for generation after generation, and then this artificially-grown ferment may be used to infect fresh animals, who in turn have the disease just as if they had taken it in the natural way.

Last, but not least, the studies and discoveries of each succeeding year point stronger and stronger in this direction as the explanation of the phenomena. That is, as our knowlledge increases, the reasons increase for believing this theory to be the true one, and the objections diminish. I certainly think that it furnishes the most plausible and philosophical explanation of the facts observed in this class of diseases, and hope, when our knowledge is further extended, that we will be able to control even those pestilences which have so long been the terror of our race. The main objection to the theory is that it is *not proved* to be true with the great majority of the diseases of this class. It is *proved* of only a part of them; with the remainder it remains as yet but an hypothesis.

Its household applications are too obvious. This class of diseases is known to sanitarians under the popular but unsavory name of "*Filth Diseases.*" With some of them it is believed that their germs are actually produced in decaying filth, with others that they are distributed through filth, and it is known that all are aggravated in their severity by filthy surroundings. If this theory be true, it gives us an inkling of why human excrement is so fearfully dangerous when it contaminates wells, or other drinking-water; it gives a reason for boiling or filtering impure water before use for drinking or in food, and of the purifying action of heat generally; it strongly indicates the necessity of keeping decaying garbage and slops away from our houses; it gives us hints about the purification of sick rooms and other foul places, and gives a philosophical basis for the sanitary care of our domestic animals, ourselves, and our homes.

The CHAIRMAN. An opportunity will now be afforded for any questions which any lady or gentleman may desire to ask. I presume Prof. Brewer will answer them very cheerfully.

Mr. **Augur.** There is a trouble that sometimes occurs in certain neighborhoods, called "stringy bread." What is the cause of it?

Prof. **Brewer.** "Stringy bread" and "ropy milk" both come from a fungus analogous to a ferment. When a bakery or a house becomes infected in that way, it is a pretty difficult matter to get rid of it. I do not exactly know what is the best way. Very similar to that, but a great deal rarer, is "bloody bread," in which particles of bread are found that are perfectly red. I have only seen two cases of that. I had one specimen in which pieces of bread as large as your fist were blood-red. It is caused by a fungus which is very difficult to get rid of after it has started. The atmosphere of a house may become infected with the germs, and it is very difficult to get rid of them.

Mr. **Perkins.** Where milk and cream are infected by this fungus, is butter affected in any similar way by any kind of parasitic fungus?

Prof. **Brewer.** I do not know that it is. I never heard of it. The changes which take place in butter spring from another cause. It is a true chemical change which takes place. There may be some such change take place in butter. If so, I have never seen it proved.

Mr. **Olcott.** I would like to ask the professor if he ever happened to make a study of the mold in "ropy cheese."

Prof. **Brewer.** That comes from "ropy milk." I will say here, that the Experiment Station has undertaken to investigate the subject of "ropy milk." It looks as though it resulted from unsanitary conditions about the place, perhaps in the water. That is what Prof. Law thinks it comes from. In the next report of the Experiment Station, there will be a paper by Mr. Sedgwick on that subject, in which he will detail all that he knows about the matter.

In this connection, I will say a word about the Experiment Station. I have been asked about the analyses performed there. We profess to analyze fertilizers for any farmer in the State who is buying them. If he has any fears that he is getting commercial fertilizers that are not what they should be, and wishes to ascertain their purity, if he will send us samples, we will analyze them. If half a dozen or a dozen in one neighborhood, should all send the fertilizers of one manufacturer at the same time, of course it would be unnecessary to analyze them all. These analyses are made free for the benefit of the farmers of the State who are using commercial fertilizers. If any of you want information on that subject, or upon any other where science can be brought to the aid of agriculture, if you will drop a line to the "Experiment Station, New Haven," you will receive such information as may be in the possession of the persons who have charge of the work. This is done free of charge to farmers.

Mr. **Hubbard.** What bearing has the subject which Prof. Brewer has been discussing upon the controversy which arises every summer in regard to curing hay? I presume that every one who reads the papers knows that when summer comes, some one will write that hay ought to be dried so thoroughly that it will not heat; and thereupon somebody else says that it ought not to be dried so much as to prevent its heating a little. I understand that heat in a haymow is fermentation.

Prof. **Brewer.** Analogous to it.

Mr. **Hubbard.** I understand that it promotes digestibility, and therefore it is a fair presumption that a larger portion of the hay is rendered more digestible when it is put into the mow with some moisture in it than when it is perfectly dry. Therefore I have taken some comfort from the professor's remarks. I have put in my hay when it was so moist that the water stood in drops on the mow, and I found the hay sweet and palatable. I should like to have the professor's opinion on that subject.

Prof. **Brewer.** I am inclined to think you are right, provided the hay does not mold. Up to the point where it begins to get moldy, I believe it may be as moist as you please.

Mr. **Hinman.** It seems to me that we could get at the solution of this question. Mr. Gold told us the other day that our corn meal must be kept in a state as nearly as possible entirely free from fermentation. Our friend, Mr. Olcott, has some very good corn meal. If we could get the Experiment Station to see whether his corn meal can be improved for human food, so that we should like it better, and it would be more digestible, by any amount of fermentation short of molding, there would be some chance of arriving at definite results, instead of any theory that we may have now.

Mr. AUGUR. I would like to ask the Professor if the Experiment Station has made any examinations in relation to adulterations of food.

Prof. BREWER. Of cattle food, yes. I do not recollect that they have of any other food. I think, while there is a great deal of adulteration going on in human food, that matter has been very much exaggerated by the sensational statements which have appeared in the papers. I have examined some things myself that were liable to be considerably adulterated. There is a great deal of adulteration of the kind that affects the pocket, but does not affect the health, like the use of dextrine in sugar, or oleomargarine in butter. These frauds affect the pocket, undoubtedly. I do not know that these adulterating substances are necessarily bad for the health.

Mr. AUGUR. What I had particularly in mind when I asked the question, was this: A confectioner told me, within two or three months, that ground marble had been used quite largely in the manufacture of candy, and that cheap candy almost invariably contained a certain proportion of ground marble.

Prof. BREWER. As a general thing, the adulteration of candy is more harmless than that. Confectioners put in a great deal of flour, and I think I have seen candy containing gypsum, but not in this State. The white clay called *terra alba* is reported as used in candy. Pulverized slate is largely used in the manufacture of paper, to make it a little heavier.

Mr. WINSLOW. Is a cellar a good place for vegetables?

Prof. BREWER. Yes, if it is a good cellar.

Mr. WINSLOW. What is "a good cellar"?

Prof. BREWER. A good cellar is one that is dry and cool—never gets wet.

Mr. Wetherell. I would like to inquire what effect the souring of milk has upon its nutritive qualities?

Prof. Brewer. I do not suppose it affects its nutritive qualities at all, but I do not know how it affects its digestibility.

Mr. Perkins. Do you consider that a stream of water running through a cellar is a disadvantage to the cellar? I have known of such cases, and never heard any complaint that the cellars were injured in any way.

Prof. Brewer. I should not think that would be specially bad. I never lived in but one house that had a spring in the cellar, and in that case the water did not run through. I cannot say that was a success as a cellar. The trouble about cellars keeping things sweet very often arises from the filth that gets on to the bottom of them, in one way and another, which does a great deal of harm.

Adjourned to evening.

EVENING SESSION.

The closing session of the Convention was opened at 7½ o'clock, Mr. Day in the chair.

The Chairman. *Ladies and Gentlemen,*—You will be addressed by Mr. Leander Wetherell of Boston, Massachusetts, on "Bread."

BREAD, THE TYPE OF VEGETABLE FOOD: THE THEORY AND ART OF MAKING IT.

BY LEANDER WETHERELL.

Bread is a comprehensive term, and is often used as the type or symbol of food, including everything eaten as nourishment by man. In this broad and comprehensive signification, the term bread comprises the entire list of articles used as human diet. In the restricted or more limited sense, the word bread includes only the various forms of farinaceous food subjected to the process of culinary art; and as defined by Professor E. N. Horsford, it comprises loaf bread, rolls, and biscuit, the cracker, the merely boiled dough, the griddle-cake, and the numerous fancy forms of farinaceous confectionery. When fitted for food they have for the most part a light, cellular, or porous structure. The practical advantage of porosity in bread is, that the gastric juices penetrate it more readily and quickly, and thus perform their function. The great objection to "heavy" bread is its indigestibility, digestion being retarded because the digestive fluids come in contact with the outside only of heavy, compact bread when taken into the stomach; hence indigestion follows the use of bad bread, a difficulty when it becomes chronic that is popularly known as dyspepsia, one of the most distressing of human ailments. More of this in the sequel.

Of all the various cereals of which bread is made, wheat is the best, and to it is given the first place among the numerous plants used as vegetable foods. Breadstuffs, popularly speaking, include wheat, rye, maize, and oats; all being the fruits of plants of the order *graminaceæ*, called the grass family by botanists. Hence, the significance of the remark of the Prince of the Apostles, when he said, "All flesh is as grass." Yet a greater than the Apostle had said, "Man shall not live by bread alone." That he does not so live has been very clearly set forth and demonstrated by the various papers that have been read during the present annual session of the Connecticut State Board of Agriculture.

Wheat, the chiefest of the cereals comprised in the order of the farinaceous food-producing plants, is of unknown origin. It is cultivated and grows well between the parallels of twenty-five and sixty degrees of North latitude, where it is more generally grown than in the southern hemisphere.

While wheat is raised in the northern hemisphere over a large extent of territory, the chief wheat-growing countries of Asia are those situated between the Black Sea on the north and the heads of the Persian Gulf and the Red Sea on the South. Egypt and the countries bordering on the Mediterranean are the wheat-producing parts of Africa in the northern latitude. The best wheat-growing portions of Europe are Turkey, Hungary, Italy, France, Spain, southern Russia, the German Empire, Austria, and Great Britain. In North America the wheat-growing section is indeed very extensive, including the United States, Mexico, and the Canadian Provinces. The great valleys of the Ohio, the Mississippi, and the Missouri rivers have resources almost sufficient for growing breadstuffs for the population of the globe. South America and Australia are also suited for growing the finest wheat. It has the widest range of *habitat* of the cereal family,—palpable evidence that it was fittingly designed by the Creator for producing breadstuff for man. In further proof and confirmation of this view is the fact that brute animals seem to prefer maize, oats, and barley to wheat as food, while the reverse is true of man. Therefore with the human race wheat stands first and highest for the purposes of bread-making. No other breadstuff makes as wholesome, healthful, digestible food for man as wheat-meal and wheat-flour, in the almost endless variety of forms in which they are prepared for human diet.

The varieties of the wheat-plant are much more numerous than those of any other cereal plants. Wheat is known to botanists universally as *Triticum vulgare*. There are from 150 to 200 described varieties of this plant; and new ones are annually added to this long list. Among the most noteworthy differences to the eye of the common observer are the bearded and the beardless; the most essential differences of varieties are those which refer to the composition of the grain in regard to quality. Wheats are characterized, says a popular botanist, by such terms as red, white, relating to the color of the kernels; bearded or beardless,—that is to say, with or without awns; winter or summer, the former being sown in the fall, the latter in the spring; soft or hard, the soft wheats being tender and floury, the hard being tough, firm, and horn-like in appearance. This last distinction is among the most important, as it indicates a real difference of chemical constituents, and, consequently, of food value. As it regards good, better, and best of these numerous varieties of wheat, there is a great diversity of opinions, and these for a great diversity of reasons, many of which are quite independent of the variety which may be deemed the best for making good, wholesome bread.

The average yield of wheat, says an English writer, is 30 bushels per acre, weighing 60 lbs. per bushel. The weight per bushel varies from 55 lbs. for wheat grown in a very wet season, to 64 lbs. in a good season. It is the plump, smooth grain that weighs heaviest per bushel. The wheat kernels vary in specific gravity from 1.29 to 1.41, the harder kernels being the denser. The proportion of grain to the straw in dry seasons is greater. These are facts that cannot fail to interest both growers of and dealers in wheat—the breadmaker, meanwhile, not being a disinterested party.

Reference has been made to the composition of the grain of the wheat-plant. This is known to vary greatly in the relative proportions of starch and nitrogenous matters. The soft, white, tender varieties of wheat, consisting of opaque grains, range from 8 to 9 per cent. of albuminoids, while the hard, translucent varieties, used for making macaroni, have been found to contain from 18 to 20 per cent. Wheat grown in fine, dry seasons shows an increase of starch and a decrease of albuminoids, the reverse of this being the case in wet seasons.

The hard, translucent wheats grown in the warmer parts of Europe furnish twice the flesh forming material from an equal weight of grain as compared with wheat grown in cold regions. Macaroni, vermicelli, Italian pastes, and various other like preparations are made from highly nitrogenous varieties of wheat. The highest percentage of nitrogen, given in Kerl & Stohlman's Chemistry, of wheats grown in Europe, is that grown in Eriwan, between the Caspian and Black seas, set down at a percentage of 4.30; and next to that was wheat grown in the south and southeast parts of Russia.

The genuine quality and excellence of bread made of wheat are not due to or dependent upon any single peculiarity in the process pursued by the baker, but are largely ascribable to the combination of changes to which the grain is subjected from the time the seed-wheat is selected and sown, through the growth and maturing, harvesting and thrashing, transportation, keeping in the granary or elevator, and milling, down to the time when the flour selected is made into bread by the baker.

Great care needs to be taken in the harvesting and drying of wheat in the field preparatory to threshing. When the grain is threshed and cleaned, ready for storing, great care must still be exercised to prevent damage from heating. If the grain be not thoroughly dry when threshed and winnowed, it should be occasionally stirred that it may be exposed to the air, and thus prevent or destroy any microscopic vegetation or mold the spores of which are developed by the moist or not thoroughly dried surface of the wheat kernels, thus injuring the quality of their contents. American storehouses are generally furnished with elevators, by the use of which the desired dryness of the grain may be and ordinarily is secured.

The normal condition of wheat is sometimes greatly impaired by blight, rust, ergot, honey-dew, Hessian fly, weevil, together with unfavorable seasons. The wheats of commerce are rarely found to be absolutely pure. Besides dust, chaff, and vermin, there are numerous foul seeds that should be separated from the wheat before grinding or milling, such as garlic, charlock, cockle, mustard, chess, grass-seed, etc. All this foul stuff, with blasted or shrunken kernels, smut, ergot, rust, etc., must be separated and removed from wheat before breadstuff of *pure* quality can be obtained. All these things serve not only to discolor the flour and thus depreciate its commercial value, but to impair its nutritious quality. These weed-seeds sometimes give the bread an unpalatable taste, besides rendering it unwholesome as an article of diet. Thus is clearly manifest the importance of both care and cleanliness.

MILLING OR GRINDING WHEAT.

The wheat being in its normal purity it is sent to the mill to be ground into meal or flour, as desired. The great importance of the processes of milling or grinding, including the flour-bolt, will be admitted by all. This must be treated briefly for the want of time.

The earliest method of pulverizing wheat for food was by the use of the pestle and the mortar, an art that prevailed in what historians call the Stone age. Subsequently the mills of the ancient Hebrews came into use. A mill of this kind for grinding wheat consisted of two circular, portable millstones, about eighteen inches or two feet in diameter, the lower of which was fixed and had its upper surface slightly convex, fitting into a corresponding concavity in the upper stone. The latter had a hole in it through which the grain passed, immediately above a pivot or shaft rising from the center of the lower stone, and about which the upper stone was turned by means of an upright handle fixed near the edge. It was worked by two women seated on the ground facing each other, both having hold of the handle by which the upper stone was turned round on the nether millstone. Frequent reference is made in the sacred scriptures, from Exodus to Revelation, as to this method of grinding wheat for bread, a mode of grinding still retained, say travelers, among the people of Asia.

The construction of mills for grinding grain were very simple down to the beginning of the present century. A pair of millstones, the upper and the nether, with a single bolt, were used for many generations, and driven by wind, water, or horse power. In the early part of the present century improvements in milling began to be made both in Europe and the United States. There is not time even to sketch these wonderful improvements made within the last half of the present century, and besides, if there were, it would be quite impossible to describe here the numerous operations, including grinding, re-grinding, and sifting, which the grain now undergoes in the high milling process. The flour thus produced is less in quantity and less nutritious, though finer and whiter than that from the former methods.

The following is a classified list by Prof. Church of the chief products of an improved flour-mill, with the average quantities of each product obtained from 100 lbs. of good white wheat:

Flour.

1.	Finest flour,	42	lbs.
2.	Seconds flour,	18	“
3.	Biscuit flour,	9	“
4.	Tails or tailings,	3	“
5.	Middlings or fine shorts,	8	“

Bran.

6.	Coarse sharps,	3	lbs.
7.	Fine pollard,	3	“
8.	Coarse pollard,	6	“
9.	Long bran,	3	“

These several quantities are estimates, and the names given may vary in different mills, whether at home or abroad. The first three kinds or qualities of flour are often mixed and sold as “fine flour,” and the quantity of this product is further raised or increased to 80 per cent. of the wheat taken by re-dressing the tailings and re-grinding the middlings, which form a link between flour and bran. In some flouring mills only three kinds or degrees of fineness are made, namely, flour, middlings, and bran.

Bran is not only richer in fibrin and mineral matter than fine flour, but also in fat. The indigestible fibrous matter of bran forms one-sixth of it, but of fine flour not one-hundreth part. For one part of flesh-formers in bran there are less than four parts of heat-givers, reckoned as starch. One pound of wheat bran contains flesh-formers equal to more than two and one-third ounces of dry nitrogenous substance of flesh. Bran contains a substance called cerealin, which acts like a ferment in causing the change and solution of other substances, and aids digestion when whole wheat bread is eaten.

The preparations of wheat as articles of diet are very numerous. Frumenty, once popular in England, was made from whole kernels of wheat soaked in water and boiled in milk, prepared somewhat as rice now is, and deemed a wholesome diet. Other preparations may be named, such as *semolina*, a kind of paste used for soups. It is usually prepared from hard wheat rich in flesh-formers—wheat of the same kind that macaroni, vermicelli, and the large variety of Italian pastes are made. Groats or grits differ from semolina by the presence of the husks of the grain in greater or less proportions.

THEORY AND ART OF BREAD MAKING.

The making of bread as an article of human food dates from an early period. The first mention of bread in the Bible is in Genesis iii, 19—"In the sweat of thy face shalt thou eat bread," was said to Adam. The word bread was used here in the comprehensive sense of the word "food," which has been described. The next mention of bread is in Genesis xiv, 18, "And Melchizedek, king of Salem, brought forth bread and wine." The first record of kneading bread is recorded in Genesis xviii, 6, "And Abraham hastened into the tent unto Sarah and said, 'Make ready quickly three measures of fine meal, knead it, and make cakes upon the hearth.'" The pious Abbé Fleury commenting upon the frugality of the patriarch said, "We have an instance of a splendid entertainment prepared by Abraham for the three angels. He set a whole calf before them, *new bread* baked on the hearth with butter and milk. The three measures of meal must have made 56 lbs. of bread; hence it may be inferred that angels were great eaters, as were Homer's heroes."

The word bread is of frequent occurrence through the Bible, it being employed both literally and symbolically. There is no word in the vocabulary of the cook, appertaining to the kitchen or culinary department of a domestic household, that signifies as much in relation to human health and happiness as the word "bread." Bad bread, bad health; bad health, domestic infelicity and unhappiness. If it be allotted to man to live three score years and ten, and all this time he must subsist on bad bread, the significance of the question put by a late English author, "Is life worth living?" becomes one of very serious import. Bad bread is the rule and good bread the exception in the family and in the hotel, in the boarding-house and the restaurant. Horace Mann, the great American apostle of educational reform, said in one of his eloquent addresses, "There is more dyspepsia produced by eating bad bread than by any other cause." When you observe a wife clamoring for "woman's rights," for office, and for the privilege of voting, you have not far to look for a dyspeptic, unhappy husband: so reasoned Horace Mann. The diligent, faithful, and skilful discharge of household duties in woman's home, where she is queen, is both more womanly and creditable than her claim on the public platform for woman's rights. A *mannish* woman is almost as much to be deprecated as a *womanish* man, the former being quite as unfit to discharge the duties of a good wife as the latter is to perform the duties of a good husband.

Governor Andrew put to a gentleman, introduced to him by the speaker, seeking to obtain a commissary appointment during the late war, as his first inquiry, "Can you make good bread? I find in my experience that good bread is the exception, and bad bread the rule." The office-seeker answered in the affirmative, he being a hotel-keeper in western Massachusetts.

The first bread-maker of which we have any record, was Sarah, the *good* wife of the noble old patriarch, Abraham. Woman, as wife, and mother, has been the chief among domestic bread-makers from that time to the present. Whether she is to remain so in the "new age" dreamed of by "modern thought," is more than doubtful.

Attention is now invited to the consideration of the three leading and popular methods of the art of bread-making.

First—The theory and art of making "Yeast bread."
Secondly—"Aerated bread."
Thirdly—"Phosphatic bread."

First. Yeast bread. Yeast is a well known substance in the culinary department of every household. It consists of budding cells, or a particular condition of the development of a certain fungus. The fermentation of the dough of what is called raised-bread, depends upon the action of yeast-fungi in the dough. Fermentation is defined—a change of organic substances by which their starch, sugar, gluten, etc., are, at the same time decomposed, and their elements are recombined into a new compound, as seen in dough. Under this name are understood various processes of decomposition of organic compounds, although it would be desirable to restrict it to those taking place with the co-operation of living organisms. The most familiar examples of the fermentation produced by the growth of living organisms are those which convert saccharine infusions into spirits, vegetable juices into beer, wine, etc., and occur in solutions of nitrogenous vegetable substances containing saccharine matters or other ternary compounds with a certain amount of nitrogen. The vinous fermentation depends entirely upon the growth of yeast, a microscopic fungus, in the liquid, or other nitrogenous substances. A cent's worth of baker's yeast contains countless numbers of yeast-plants. They constitute the value of brewers' and distillers' yeast. They are the chief elements produced by using recipes for making hop-yeast, bran-yeast, potato-yeast, etc. The old-fashioned name for yeast was "emptings," a word not found in dictionaries, "emptyings" being the word that should be used as the synonyme of yeast. It is estimated that a single cubic inch of air-dried press-yeast contains 1,200,000,000 of minute yeast organisms. It is known that dough too far advanced in fermentation (old leaven) yields offensive products both to the taste and smell, including butyric ether, and other offensive products.

Yeast, for bread-making, is the product of the yeast-plant, and is capable within a limited time of producing alcohol and carbonic acid. Yeast, by its action on dough, gives the quality of lightness to bread. Such a yeast was the ideal yeast sought by the Vienna bakers, says Professor Horsford. The press-yeast dates back to 1847, and the introduction of yeast from beer to 1817. Down to that date, sour dough, or a mixture of sour dough and a decoction of hops, were the means for producing porous bread throughout Austria and Southern Europe. About this time the bakers introduced into the bread-market of Vienna a roll, made of a fine quality of flour by a process of "*sweet fermentation*" (with yeast), called the imperial roll (*Kaiser-Semmel*).

The prize medal offered in 1847 was awarded in 1850 for the "cereal press-yeast." From this time a highly improved quality of bread was produced throughout the Austrian Empire. At the Paris Exhibition in 1867, the Vienna bakery was pronounced the first in the world; and to Vienna belongs the double honor of developing the art of high milling, and the discovery of what is called "press-yeast." The sale of press-yeast by Mautner & Son, in 1846, was 72,400 lbs.; in 1852, 380,600 lbs.; in 1862, 1,144,500 lbs.; and in 1872, 3,170,000 lbs. In 1873, the international jury awarded to this firm the grand diploma of Honor.

Press-yeast is obtained by skimming the froth from the malt-mash in active fermentation, which contains the upper yeast, and being repeatedly washed with cold water until the pure white yeast only settles clear from the water. This soft, tenacious mass, after the water has been drawn off, is gathered into bags and subjected to hydraulic pressure until there remains a semi-solid, somewhat brittle, dough-like substance, still containing 80 per cent. of water. This is the press-yeast. It is then made into packages of definite weight up to four pounds, and wrapped in paper and supplied to the market. Such yeast in summer will keep for several days, and for a much longer time on ice.

Having provided the best yeast, which is the "press-yeast," the difficulties of bread-making are not all overcome. Household bakers do not, as already stated, succeed uniformly in making good bread. Objectionable qualities as to smell, taste, and touch are manifest, such as render it unpalatable, unassimilable, that is to say, indigestible, and therefore unhealthful. Such too often, alas! is the kind of bread one has to eat, or to go without this farinaceous article of diet, not inaptly called the "staff of life." The reasons for the lack of good bread are various aside from the ignorance of the art of bread-making on the part of the cook, such as bad flour made of grown or heated wheat, while curing, heated in grinding, etc. The quality of yeast is variable as are most of the other conditions which encumber the problem of making uniformly good, nutritious, healthful bread.

The effects of fermentation may be said to be both beneficial and hurtful. Of all the effects produced by fermentation, it is generally claimed for it that the most important and perhaps the most essential is, that it gives bread porosity, or serves to make it "light," and thus to promote its digestibility. Most acids, except carbonic acid, are more or less hurtful. Baron Liebig proposed the use of lime-water to neutralize the acid, a suggestion that met with general acceptance. Alum and sulphate of copper have been widely used. Dr. Hassall, on examining twenty-four samples of bread in London, found alum in all. Dr. Muspratt found that the same was true of bread in Liverpool. In Belgium, Dumas found the sulphate of copper (blue vitriol) in use, and had been from an early period. Kuhlmann found that a pipe-bowl full of the solution was used for 250 lbs. of bread. Bread thus made is whiter and contains more water, both being in the manufacturer's favor, and against the consumer's interest. A like result is produced by alum. These are among the secrets of the art of adulterating the quality of commercial bread.

Mould or the organic germ from which it springs is sometimes poisonous, and to it are traced the worst forms of dyspepsia. The existence of microscopic organisms in yeast is a fact which no scientist doubts. They are the concomitants of *decay*, as taught by Liebig. As a class, microscopic fungi are poisonous, as stated by organic chemists. The forms of mould in cheese and in chestnuts are known to be poisonous. The fungus (ergot) that appears in the heads of rye is deleterious to human health. The rust of wheat and the smut of maize have sometimes proved poisonous. The effects of ferment and the incidental deterioration of the flour by the incipient disintegration of the gluten are known to chemists.

Ergotised or spurred rye, well known to observing farmers, is poisonous to animals. The symptoms are of two-fold nature, namely, those of deranged nervous action, terminating fatally sometimes, and at other times attended with gangrene of the extremities. Deleterious properties are also attributed to unripe wheat. Bread made of bad flour becomes more unwholesome by being kept, especially if it develop fungi, or in other words, becomes ropy and mouldy. Dr. Christison says that repeated instances of poisoning have occurred in Europe, of severe and even dangerous character, by the eating of spoiled or mouldy bread made of wheat, of rye, and of barley; and that several cases have been observed of horses having been killed by the eating of such bread. Mouldy oats have produced like results. Dr. Parkes, quoting from Professor Varnell, states that six horses died in three days from eating mouldy oats; there was a large amount of mycelium, and this being given to horses for experiment, killed in 36 hours. Let farmers and stable-keepers make a note of these well-authenticated statements.

In cities, mouldy bread is less common than in the rural sections. The daily supply of bread prevents this. Among farmers where batches of bread are baked some days apart, ropy, mouldy bread is less of a rarity than among the denizens of large cities.

Flour should be thoroughly kneaded with water and yeast by every bread-maker. Let this be heeded. The lack of kneading is a common defect in the art of bread-making. The dough should stand a sufficient length of time for a thorough and complete fermentation.

The intrinsic difficulties of the problem in the way of producing an ideal loaf of bread, as now seen, are in the number of unknown conditions in relation to both the yeast and of the flour, together with the varying skill of bread-makers. All attempts, therefore, to establish the art or method of making fermented bread of uniform good quality have failed. Said a good housewife to me, "Every bread-maker of the household claims that *she makes* good bread." Said a cook, "I should like to see any one who makes better biscuits than I do," when the fact was, that they were so clammy, soft, tenacious, and sticky, that the part within the crust could easily have been moulded into pellets or pills, quite as indigestible for delicate human stomachs as buckshot.

The second topic for consideration is

"AERATED BREAD,"

an invention introduced into England by Dr. Dauglish, in order to avoid fermentation, or the use of yeast, leaven, or sour dough in the art of bread making. Carbonated alkali and muriatic acid mixed with flour, were found to give to bread its requisite porosity. The mixture of saleratus (carbonate of potassa) and sour milk (lactic acid) were among the substitutes for yeast. The mixture of dry tartaric acid and bicarbonate of soda with flour was found to produce light, palatable bread. Cream of tartar was substituted for pure tartaric acid, to be mixed with bicarbonate of soda, as another expedient to shorten the process of bread-making, and in order besides to avoid the use of yeast or sour dough.

Dr. Dauglish discovered that the essential quality of an agent for making the dough porous was a source of carbonic acid in every part of the moistened flour, and realized the practical working out of his idea by mixing the flour in a confined space with water charged under pressure with carbonic acid (soda water). The dough so formed, when exposed to the air of ordinary atmospheric pressure, expanded under the influence of the carbonic acid until the whole possessed the cellular and porous structure of thoroughly leavened dough, when it was immediately put into the oven and baked. The dough for aerated bread is made in a strong iron vessel, under pressure; when this is put into the oven, it rises as the gas with which it has been charged expands and escapes on being withdrawn from the pressure of the mixing vessel, and on being heated. Aerated bread differs considerably in taste from ordinary yeast-made bread, and is much less generally liked. People who like it at first very soon tire of it. In this process of bread-making the dough is not touched by the hands of the baker. Vesiculation is produced by the expansion of the carbonic acid gas with which the dough is incorporated. This process of bread-making requires but three ingredients—flour, water, and carbonic acid gas. Nothing occurs to change any part of the flour but the action of heat in baking. It is one of the purest forms of wheat bread that is made. While there is nothing disagreeable to the taste, it lacks the flavor of yeast-bread, to which people have long been accustomed. It keeps good and sweet much longer than fermented bread. The process of making aerated bread adds nothing to its nutritive quality, neither does it impair it by decomposition incident to fermentation.

It remains, thirdly, to consider what is denominated

"PHOSPHATIC BREAD,"

Claimed by the late Baron Liebig and others to be the best method yet developed in the theory and the art of bread-making. The inventor or discoverer of the art of making phosphatic bread, Prof. E. N. Horsford of Cambridge, Mass., claims that it is quite superior to the Vienna bread. At the Paris Exposition in 1867, the Vienna bakery was recognized as the best in the world. Vienna, it will be remembered, was the birth-place of "press-yeast."

Flour-bread, as ordinarily made, is deficient in the two most important nutritive constituents of the wheat, namely, the albuminoids contained in the gluten-coat of the kernels of the grain, and the phosphates found with them. Both of these properties are separated from the fine flour by the milling processes. The average or mean percentage of nitrogen is about two, ranging from 1.68 to 2.25, as found at the Pesth cylinder mill at the Vienna Exposition. The phosphoric acid was found to be one. It was stated that bread made of whole-wheat-meal is more nutritious than bread made of fine flour. Said Baron Liebig, "The nutritive salts of meat and of wheat are phosphates, and consist of compounds of phosphoric acid with potassa, lime, magnesia, and iron ; the simple relations of the quantity of these substances contained in wheat and flour, as shown by chemical analyses, make the nutritive value of the two obvious."

The researches of Magendie, made some years ago, established beyond doubt that, for purposes of nutrition, bread made of whole-wheat meal, as compared with bread made of fine flour, is greatly superior. He found by experiment that dogs fed on white wheat-bread alone after a few days became sick, lost strength, and soon after died, while dogs fed on bread made of whole-wheat meal lived in health and vigor.

Chossat found by experimenting that absolutely clean wheat—wheat that had been washed to remove all traces of calcareous earth adhering to its surface—would not sustain pigeons in health when supplied, in addition, with absolutely pure or distilled water only. After a time their bones became thin and weak, not being of sufficient strength to support the weight of the birds, the phosphate of lime of the bones having been transferred to sustain the activity of organs more essential to life. They, like the dogs fed on fine flour, very soon died. Pigeons fed on the same kind of wheat and the same kind of pure (distilled) water, having access to lime, lived on in perfect health. Even pigeons that nearly perished from having been fed upon the diet first named, upon being furnished with carbonate of lime were soon restored to health. Such are facts of great interest to those who would subsist on wheat-bread. Black bread is much more nutritious.

It is a well-known fact that the peasantry of Europe subsist largely on bread made of whole-wheat meal. The same is true of people in Great Britain, Canada, and the United States. Oat-meal, rye-meal, and maize-meal are largely used for bread-making. These facts go to show the importance of phosphates in bread, as they enter largely into the making up of the elements of nutrition, they being indispensable to, and demanded by, all higher organisms. It is a fact that cows do better on pastures dressed with bone-meal as a fertilizer. Bone-meal mixed with maize-meal for milch cows is considered important in food rations as prepared by some dairymen.

Mr. Meyer, a German chemist, demonstrated by experiment, in 1871, that the restoration of the phosphatic constituents of the bran to flour-bread rendered it more nutritious. This was done by an acid phosphate of lime and magnesia in the form of dry powder, which being mixed with an alkaline carbonate sufficient to neutralize the acidity of the phosphoric acid, and these mixed or thoroughly incorporated with the dry flour in such a quantity as to restore to it the phosphoric acid, lime, magnesia, and alkali lost with the bran, gave the dough the porosity or cellular structure, which is preserved by immediate baking. The changes produced thus in the flour are less than those produced by yeast, and it is attended by no deterioration of nitrogenous constituents to supply material for yeast fermentation. Press-yeast, or leaven of any kind, being used in making bread, causes deterioration and loss of nutritive matter to a considerable extent. In case of inferior leaven or yeast, the deterioration is not confined to the degradation of nitrogenous constituent and of starch, as it yields lactic, acetic, and other acids, and also offensive exhalations which are manifest in imperfectly raised yeast-bread, leaving it in a heavy, sodden, indigestible, unpalatable state, all of which effects are or may be avoided by the process of raising bread with acid phosphate and carbonated alkali. Bread thus made is whiter than yeast-bread, and, besides, bread thus made contains no yeast-plant germs, the result of decomposition and decay. The crumb retains its elasticity and is more easy of digestion. But the chief advantage is that mentioned by Liebig, namely, "the increase in the nutritive value, amounting to from 12 to 15 per cent., arising from the restoration of the phosphates lost with the bran." This bread, being free from yeast-plant germs, is less likely to mould than yeast-made bread, and is, therefore, a grand army bread as well as family bread, where long keeping is desired.

This mode of making bread was introduced into Germany by Baron Liebig, and met with general acceptance, "the same quantity of flour making more and better bread," as he claimed.

This new method of making phosphatic bread is deemed a valuable discovery in the art of bread-making. The idea which led to this discovery was the production, each by itself, of the two ingredients, the acid and the base of a normal salt present in the cereals and all healthful food, and essential to the production of all the important organs of the body, in such form that the two, mixed with flour, meal, or buckwheat for griddle cakes, in their application unite therewith to restore the normal salt, thus evolving carbonic acid from the midst of the dough to make the bread porous. Of all the salts taking part in vital processes the most important are the phosphates, as they enter into the composition of the bones, muscles, nerves, brain, and indeed of every higher tissue; and whenever an important function is to be performed nature seems to have supplied a store of phosphates. They are present in all the normal forms of substantial food. In ordinary wheat-flour the normal phosphates contained in gluten are separated with the bran. Meyer found the percentage of phosphoric acid in bran to be 2.82, while the percentage in fine flour is only 0.20,—that is to say, the bran contains, weight for weight, more than fourteen times as much phosphoric acid as the superfine flour. Thus in introducing phosphates into bread an important ingredient of food is added thereto. To secure the more important of these in bread, with the incidental evolution of carbonic acid, it is only necessary to mix with the flour a dry, highly acid phosphate of lime, which is phosphoric acid and neutral phosphate of lime and dry bicarbonate of soda, in such proportions as shall leave a neutral phosphate of lime and phosphate of soda after the dough has been thoroughly kneaded and baked.

This is denominated the phosphatic method of bread-making; and the bread thus made, it is claimed by Baron Liebig, is pre-eminently wholesome and health-promoting, leaving no ground for even a theoretical doubt relative to this important conclusion.

To make good fermented bread uniformly is a problem encumbered with many insuperable difficulties, arising from various sources, such as the variable qualities of flour, yeast, etc. No other method of bread-making adds anything to its nutritive quality but the phosphatic. The advantages of this method of bread-making over the former two methods as presented and described above are such as led Baron Liebig, in 1869, to write to the *Allgemeine Zeitung*, a journal on Chemistry, etc., as follows:

"It is clear that if, instead of the bran of the wheat and rye flour, we restore the nutritive salts of the bran, when we take into account that the nutritive value of the flour is at least 12 per cent., often 15 per cent. less than that of the wheat, this restoration acquires an economical significance of great national importance, for the result upon nutrition, in the actual fact, is exactly as if all the wheat-fields in the country had produced one-seventh to one-eighth more wheat. With the same quantity of flour, through this increase, a greater number of men may be fed and nourished."

BAKING BREAD.

The process of baking changes the structure of the crust of a loaf, and according to Reichenbach develops in it a substance called *assamar*, which has influence in retarding the waste of tissue. It does not alter the starch of the crumb or internal part, but swells the granules only by the induced sponginess of the mass, and renders it easy of digestion. Well-baked bread should be of a yellowish-brown crust; the crumb should be uniform in texture, permeated with minute cavities, and without large eye-cells. The color of the crumb, unless in case of whole wheaten bread, should be white; it should be free from acidity or sourness. It should keep sweet and edible for several days; and when stale it will be found to become soft and pleasant by again heating it in an oven, after which, however, it changes rapidly.

Having thus sketched the materials of which bread is made, with the modes of grinding wheat, and the art of making yeast, aerated, and phosphatic bread, I leave the matter with the readers of this paper to choose the kind of bread they prefer, having purposely left this matter undecided, lest it might be said that I was interested in some one of the three methods of bread-making, named above. My sole purpose has been to make such suggestions as shall lead to a careful study of this most important of subjects to families. If this discussion shall tend to improve the art of bread-making, the purpose of the writer is gained.*

The CHAIRMAN. Will any gentleman question the speaker upon the subject upon which he has addressed you?

Mr. ———. Would it not be a good idea to ask the ladies to question him too, if they like?

The CHAIRMAN. The same privilege is extended to the ladies. We shall be happy to have them ask any questions of Mr. Wetherell relative to the subject-matter upon which he has addressed us. I hope they will avail themselves of the privilege.

Prof. BREWER. While they are plucking up courage, I want to say a word. I differ entirely, emphatically, and decidedly, with the lecturer upon two points. In the first place, I do not believe for one moment that fermented bread is less digestible or less wholesome than bread raised by other means. I do not believe that bread made by any patented process, by any baking powders, phosphatic, or otherwise, or aerated bread, is more digestible or healthier than fermented bread. That is my opinion, and I believe the experience of the world will show it to be true. We have not used phosphatic bread long enough, or had it used in families long enough, to be able to say that it is better than the other.

The other point on which I differ from the lecturer is this. He thinks that the art of bread-making is declining in families. I do not believe it. There is no question that there is too much bad bread, but I have an opportunity of eating bread in a great many families, and I do not believe that the art of making it is declining.

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* In the preparation of this paper I am indebted to various authors consulted, among whom I name Messrs. Horsford, Johnson, Church, Pavy, Brewer, and others, with some of whom I have conferred. My object has been to present the theory and art of bread-making as known at the present time, in order to contribute something toward improving the quality of bread in the households of the rural population of Connecticut,—the most important article of diet of our every day life, as bread has been and is called "the staff of life."

As regards phosphatic bread that has been so highly spoken of, it has certain merits. Of that there is no question, but so long as the public do not like it better than fermented bread it is hard to say that it is better. I recognize the force of what the gentleman says as regards the different nutritive qualities of bread made from whole wheat and that made from finely bolted flour. If we had to live by bread alone, perhaps we should go back to the coarse black bread that contained all the bran, and to the old buckwheat, oats, and barley, so that we should get as great a variety as possible. But we do not eat bread for that purpose. We eat meat and vegetables with our bread, and such bread, therefore, is not so great a necessity as it would be if we had not such a variety of food. If we ate merely to support life, and wanted to get the largest quantity of food at the smallest cost, we should go back to the good-old fashioned dish that we have all heard of, which will support life and vigorous health, to wit, baked beans.

I may say that fermented bread, otherwise than from the use of leaven, is considerably older than we might infer from the statement made here; it did not begin in the present century. While the use of yeast from beer is comparatively modern, the various forms of yeast called "emptyings" were in use certainly in the days of our grand-parents in the last century. Leaven was used more then than now, but various forms of yeast were also used.

Mr. WETHERELL. I did not discuss the relative digestibility of yeast, aerated, and phosphatic bread: I did refer most emphatically to the indigestibility of bad yeast bread, that kind of bread which is the most common. The same remark will apply to bad bread of all kinds. I did not refer to yeast bread as having been originated in this century, but to "the introduction of the yeast from beer," which was in 1817. The other point of difference named, is that relative "to the declining of the art of bread-making in families," which resolves itself into this, namely, our experiences differs, the Professor having been more fortunate than the speaker and the late Governor Andrew of Massachusetts, quoted, relative to the quality of family bread.

Mr. Augur. There is one question we must not forget. There is still considerable rye raised in Connecticut, and I would like to call the attention of these gentlemen to the question as to the value of rye flour or rye bread compared with wheat.

Prof. Brewer. I cannot answer. I know it is generally considered more nutritive, but I cannot speak positively. My impression is, that its use has declined, not because it is less nutritive, but because people like wheat bread better. The brown bread of Germany is certainly more nutritive than our white wheat bread, and if a person had to live on a low diet, and a very limited bill of fare outside of that, it would be a good deal better. But as we have a great many things to eat with our bread, the nutrition of bread, considered by itself, is of less importance than it would be if we had a smaller bill of fare.

Mr. Wetherell. In answer to Mr. Augur's question as to "the value of rye flour as compared with wheat," I give the analysis of both by A. H. Church, Professor of Chemistry in the Agricultural College, Cirencester, England:

COMPOSITION OF RYE FLOUR.

		In 1 lb.	
	In 100 parts.	oz.	gr.
Water,	13.0	2	25
Fibrin, etc.,	10.5	1	298
Starch, etc.,	71.0	11	157
Fat,	1.6	0	66
Cellulose,	2.3	0	161
Mineral Matter,	1.6	0	112

COMPOSITION OF WHEAT FLOUR.

		In 1 lb.	
	In 100 parts.	oz.	gr.
Water,	13.0	2	35
Fibrin, etc.,	10.5	1	297
Starch, etc.,	74.3	11	388
Fat,	0.8	0	57
Cellulose,	0.7	0	49
Mineral Matter,	0.7	0	49

I am sorry to differ with Prof. Brewer in reference to the quality of bread. That is a matter merely of personal experience. I speak from my observation, he speaks from his, and he has been more fortunate in his experience than I have been. I am satisfied from experience, from observation, and from the use of bread, that in three cases out of four bread is not what was called this afternoon pure wheat bread. I do not believe it is possible to use a ferment of the character described by him this afternoon and have the food as healthful as you can make it without the use of that stuff. He refers to the unpalatableness of phosphatic bread. I do not know that I ever heard that remark made before. I have heard the unpalatableness of aerated bread mentioned, and have experienced it myself. But with regard to good wholesome bread, I believe that it can be made and has been made without this decaying vegetable matter being put into it, better than you can make it with it.

Prof. **Brewer.** You object to the process of fermentation. What is pepsin, what is the gastric juice, and what is the effect of the saliva on digestion? I passed over the subject of soluble ferments this afternoon entirely. Pepsin is the type of them; gastric juice is the type of them; and the digestive process which goes on in the stomach is the very type of what we call fermentation by soluble ferments. I know we are liable sometimes to make laboratories of our stomachs, but I do not think chemists have yet established all the points about the nutrition of food. This much is clear, that the process of digestion is very analogous to the process of fermentation, and fermentation has been used by the race ever since the time of Noah and probably longer, and upon the whole, the race has thrived on it.

Mr. **Wetherell.** I grant that fermentation and digestion have reference to the decay and decomposition of matter; but that there is any strict analogy or any strict identity between digestion on the one hand and fermentation or "emptyings" or pressed yeast on the other, I take occasion to deny that I believe any such thing. I grant that the Professor is good authority, but still, when it is understood that the process of digestion is one that no chemist has ever yet fathomed, or ever will, probably, while it may be very easy to show an apparent analogy between the two, I deny that it is, strictly, an analogy; and I still further protest against using that nasty stuff in bread. I do not believe we ought to use it if we can avoid it. And I quote one of the best chemical authorities, Baron Liebig. He said that the process of making bread that I have described here to-night was the ultimatum of the art of bread-making.

Prof. Brewer. Baron Liebig denied the theory of fermentation down to the day of his death. The fungus that caused the potato rot was not discovered until 1847 or '48, and the reason why the discovery was put back so many years was because Liebig, undoubtedly the first chemical authority of his day—he was a genius—got on the wrong track. He took the ground that fermentation was not caused by living germs; that the fungus was caused by the chemical change, and not the chemical change by the fungus; and he never gave that theory up. In his last days, he allowed that it was a process of motion, but no further than that. But I do not know of any prominent chemist to-day, in the light of our present knowledge, who does not believe that these living ferments are the causes and not the results of the chemical change.

Mr. Wetherell. It will be remembered by those who are familiar with the life of Liebig, that when he advanced certain views in regard to the mineral elements of plants and fertilizers, Lawes & Gilbert called him to account, and charged him with ignorance and not knowing what he was talking about. But the views that Liebig then taught have been endorsed by Lawes & Gilbert, and by English agriculturists generally. I think that what I have said with regard to Baron Liebig here to-night will be found to be true, and I think our friend Brewer will live to see the day when he will prefer phosphatic bread to that made from the nasty stuff to which I have referred. I do not believe in it; my friend does—but " there is no accounting for tastes."

Mr. Whitaker. I do not believe the ladies have lost the art of making bread any more than they have lost the art of butter-making. Last week I went to the Dairy Exhibition in New York, and there I saw a woman from Minnesota who had brought her butter made up in the form of roses, crosses, wreaths, and baskets of flowers. I delivered an address there one evening, and I said there was a farmer's wife who was a dairymaid, poet, painter, and sculptor all combined; and when the electric light fell upon that butter, I said that science and electricity had combined to crown her Queen of the Dairy. That lady took the prize of fifty dollars for her butter, and she took the money back with her. I told them that night, when called upon to speak for the East, that men and women were the highest type of agricultural products, and although the farmers and farmers' wives of the West might come back and take the laurels from old Connecticut, or Massachusetts, or Vermont, or any other of the older States, we were not to forget that the influences that had been started in the older States had only gone there, and were coming back bearing their sheaves with them.

Now, Mr. President, are we going to stand here and say that our wives and our mothers do not know how to make bread? Not so. I would not say it, because I will tell you, I rarely get bad bread. When I do, it is an exception. I know there is nothing in which a woman takes greater pride than in setting before her friends, when she has company, her best bread; and I know there is not half as much jealousy among women about their bread as there is about some other things, for they begin to inquire directly, What is the best recipe for making bread? And when they get it they are always willing to pass it along to one another, and help one another out of difficulty. If we men were as ready to help one another out of difficulty as the ladies are to help one another about bread-making, we should be better men.

Mr. Gold. Miss Juliette Corson of New York was announced to speak this evening on the subject of cooking. This morning I received the following telegram: "Cannot come; have sent paper by mail to be read. Juliette Corson." The post-office has failed to deliver this communication, and therefore we are obliged to disappoint the audience at this time.

Mr. Hinman. In behalf of the farmers of Connecticut who have attended this convention I offer the following:

Resolved, That we hereby tender our thanks to the press of the State for its assistance in giving publicity to this meeting by the reports of its proceedings; to the railroad companies that have, by reduction of fares, aided in making it a success; to the people of Willimantic for their generous hospitality shown us since we came among them.

I move the adoption of the resolution.

The resolution was unanimously adopted.

Prof. **Brewer.** I have a resolution which I would like to offer:

Resolved, That the thanks of this Convention be tendered to the Willimantic Linen Company and its courteous agent, Mr. E. S. Boss, for the kind invitation to visit their mills and library.

Mr. **Wetherell.** I second that resolution, and can say that I never enjoyed a visit to any factory more than I did my visit to those mills; and what was especially gratifying was the sight of one of those large rooms lighted with the electric light. I think you have in this village, in that factory, what any town or city might be proud of, representing as it does one of the noblest and best industries of our whole country. I want to say further with regard to it that you do not know, citizens of Willimantic, how much obligation you are under to the investment of that capital here. It has built up your town; and when I saw that library, to the privileges of which not only the operatives of the factory but the citizens of the town are admitted, I felt that you ought to be grateful for what they are doing as well as for bringing their money here. I therefore cordially second the resolution of Prof. Brewer.

The resolution was passed.

Mr. **Augur.** I would like to offer the following resolution:

Resolved, That we tender our thanks to the Willimantic Farmers' Club and its officers who have so efficiently helped us; to the janitor who has so kindly cared for us, and to all who have contributed fruit, grain, vegetables, scions, syrup, or any other articles, and especially to Mrs. Clark, florist, of Willimantic, for her fine collection of plants;—that all these have our thanks for their generous contributions and care.

The resolution was adopted.

Mr. **Whitaker.** The time has come, I suppose, when we are to return to our respective homes. We met here on Wednesday morning last, many of us perfect strangers to one another. We have been together in council for three days, consulting upon the most important business that ever has been or ever will be,—that of furnishing food to mankind; not only furnishing food but furnishing the material by which we are to be clad. There have been differences of opinion on many subjects, and it is not at all strange that there should be differences of opinion on questions of such great importance as every question is that is connected with the subject of agriculture. But while we have had differences of opinion on these questions they have been discussed in a pleasant and in an agreeable manner. There could hardly have been got together as many people to discuss questions so wide and so various, where there would have been less of anything like bitter or irritable feeling; the time has passed pleasantly and agreeably.

I trust that when we go away we shall remember, and remember pleasantly, the hours that we have passed together here. There are dark clouds always lowering upon us; there are difficulties in the way at all times; and yet there are silver linings to every cloud, however dark, and there are sunny spots all through life; there are places where the grass grows green and where roses bloom, and it is upon these places that we fix our last thoughts when we leave this earth for a better place above. And, friends, let me say, as we travel through life let this be our motto: wherever we are, to extract some thorns from the pathway of life; to scatter roses here and there, so that those who follow in our footsteps shall have their feet less lacerated and find their pathway blooming where ours has been almost desolate.

Ladies and gentlemen, on my part I thank you kindly, and now good night.

The **Chairman.** Gentlemen and ladies, the winter meeting of the Connecticut Board of Agriculture is adjourned without day.

REPORT OF P. M. AUGUR, POMOLOGIST OF THE CONNECTICUT BOARD OF AGRICULTURE.

The year just past has been comparatively a barren one; the aggregate of our fruits being low compared with the year 1878, and specially so compared with the year 1874, when we had the largest aggregate on record.

The quality is also poor, especially of apples; indeed, this is generally the case with a very light crop. Most of the fruit is punctured by the curculio, or infested with the apple-worm; and this year to an unusual extent we have suffered from the ravages of the apple-maggot.

The crop of pears has been better; indeed, in some sections of the State, has been abundant.

Peaches have also done well where healthy trees have had good care and culture on new land; and people are beginning to feel more confidence in the practicability of raising at least a home supply of this delicious fruit.

Grapes, strawberries, cranberries, and other small fruits have produced fair crops, while the quince has in a few instances yielded an astonishing profit, yet as a whole our people have not yet learned how to manage successfully this excellent fruit.

Nor yet the plum, a delicious fruit, though rarely found in our markets except as brought from elsewhere; still it is a fruit which can be profitably raised by the expert and by special management, which, however, few have been disposed to give.

ENCOURAGEMENTS.

During the past year we have had occasion to note some very interesting and encouraging points of orchard management among Connecticut farmers.

1st. A more general practice in some sections of taking out old, worthless fruit trees. This cannot be too strongly commended. Our State is suffering from a careless neglect in this matter; thousands of worthless trees are cumbering the ground; yes, worse than that, they afford a breeding-place for the codling-moth, canker-worm, tent-caterpillar, apple-maggot, web-worm, and other insects, and thus are a nuisance to the owner and all his neighbors. Hence we strongly urge the grubbing out of all old useless trees. There are frequently trees standing by highways or in fence corners in pastures, which yield fruit of little value, and by the continuous dropping in autumn tempt farm stock to throw or break down fences. Unless such trees have sufficient value to warrant good care we advise removing them.

Let farmers adopt a policy of having their fruit in orchards well arranged for convenience and profit, and, as a rule, discourage scattering trees.

2d. We find that farmers are adopting better practices in pruning their orchards. Model orchards are found more frequently. Some young farmers are pruning judiciously and annually, from the first planting of their trees; this is the only right practice; taking the nursery tree, and instead of an indiscriminate shortening back, cut out the interior shoots, leaving only four or five main branches for the frame-work of the future tree.

As a rule, we should prune young trees *more* and old trees *less* than formerly has been the practice. In pruning old orchards it is very damaging to the longevity of the trees to cut out large branches; the superfluous branches should have been cut out when the trees were young. To young farmers we say, consider this matter in pruning your young orchards.

3d. Our farmers are knowing better what varieties to plant, and are planting orchards judiciously.

Taking the aggregate orchard product of our State, it is safe to assert that it would be *worth double annually* had there been a judicious selection of varieties at former plantings. Our market orchards have too many varieties. Present planters are becoming aware of this, and we are glad to note that an important change is taking place in adopting only the best well-tried varieties for planting market orchards. The great importance of this is obvious to all.

For a home supply, take the best succession of varieties running through the year. For market, plant from four to six well-tried and most remunerative varieties.

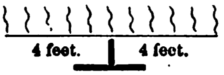
THE GRAPE.

The grape is one of our choicest fruits, remarkable for its health-giving qualities, easily propagated, and grown without difficulty under favorable circumstances. And as we have early ripening and late keeping varieties—some which with proper care can be kept in good condition nearly or quite through the winter—therefore the supply should be largely increased.

SOIL AND SITUATION.

The grape has an adaptedness to a variety of soils, and can be grown in nearly every garden in our State; but for vineyard planting a judicious selection of the site is very important; a slope of 10° or 15° to the east or south is most desirable, and if proximity to a lake or large river all the better. A good soil, rich in potash, lime, and phosphoric acid, is best; and if it has good natural drainage, through a porous subsoil so much the better; a good drainage natural or artificial, is indispensable. A soggy or wet soil is not good for the grape.

We have seen in many instances soils quite stony—indeed full of small stone, or disintegrated rock, especially calcareous shale, red shale, or vesicular trap, where the health and productiveness of the vines and the good quality of the fruit gave strong evidence of the adaptedness of such soils to produce choice grapes. However we believe that any soil capable of producing good corn or wheat, is capable of yielding good grapes.

In planting a vineyard on a slope, the vines should be planted in rows eight to ten feet apart, by wire-trellis extending along the face of the slope and parallel with its upper line or ridge, the vines should be about eight feet apart in the rows, and the vines extend arms from the main stem four feet each way,  thus, from which upright shoots are trained year by year on the renewal plan, which bear the fruit.

In attaching the wires to the posts see that the end posts are well braced, then put the lower wire so that it shall be just above the knee-pan of an ordinary man, the upper wire just above the shoulder, and the middle wire equidistant between. The best fastening for the arms and shoots of the vines is slitted corn husks, saved the previous year, and slightly dampened for tying.

CULTIVATION.

This should be frequent and continued throughout the entire season; by using a French cultivator with the handles standing a little to one side, a short whiffle-tree fourteen to sixteen inches long, and a steady, trusty horse, an expert hand can break nearly every inch of ground with only a slight occasion for the hand hoe.

MANURING.

Use well-rotted stable manure cultivated in the last time in autumn, or a liberal dressing of bone meal and ashes (unleached), or in place thereof German Potash Salts.

Our own experience with the different grades of potash salts would lead us to choose the Leopoldshall Kainit, or low grade sulphate, thinking as I do that the magnesia it contains is beneficial to the grape.

SHELTER BENEFICIAL TO GRAPES.

We have often had occasion to notice the marked advantage cultivators of the grape have had in the cities and compactly settled villages. The walls of buildings, especially if they be of brick or stone, afford an excellent shelter for vines; they absorb and conserve the strong heat of day, giving it off during the night; again, they break the cold currents of air by night, rendering the vines less subject to mildew and aiding in the full maturity of the fruit.

Tight board fences are undoubtedly excellent for the same purposes, though in less degree. They will on the south side forward the ripening process for early fruits, and on the north side serve to retard the ripening of those fruits we wish to keep back. This unavoidable shelter so generally provided in cities should be improved and appreciated. The good effect of the tight fence will be greatly increased if a course of boards one foot in width be attached to the top of the fence, supported by brackets so as to project full width from the top edge of the fence, thus making a shelter for the vines beneath. This arrangement may very well serve another purpose, viz., by suspending from the projecting edge netting or musquito-bar reaching to the ground, the attacks of rose-bugs and other insects may be prevented, and later in the season, as the fruit ripens the mischievous birds may also be kept back. The same material may, by careful use, and removing when not needed, be serviceable for years. By using available means some of the choicest grapes can be grown which do not always succeed in open culture.

CONDITIONS FOR RIPENING GRAPES.

It is generally supposed that such grapes as the Catawba and Isabella cannot usually be ripened in our climate; one thing is sure, viz., they often do not ripen as they should; but what shall we do about it? I say without fear of contradiction that healthy vines of the Catawba grape planted in a good border, properly pruned, properly sheltered, and properly thinned of fruit so as not to carry too much fruit, may have their fruit well ripened by the 20th of September, and with a little care in packing, and keeping in a temperature of 40° or a little less, that fruit may be in use up to April 1st the following year.

A tour among the vineyards of the New York lakes convinced me that much as they are favored with good climate and suitable soil, their success is in no small degree owing to the knowledge and skill attained by making grape-growing a specialty. Right methods and practices are intimately connected with success in any undertaking, and certainly so in grape-growing.

VARIETIES.

The most certain is the Concord; while the Hartford Prolific, the Ives, the Champion, Worden's Seedling, the Cottage, Moore's Early, and Lady may always be depended on to succeed with reasonable care and culture.

The Isabella, Catawba, Diana, and Delaware may almost surely be produced with a reasonable amount of skill in culture and management.

Rogers' Hybrids, and all other hybrids, the Croton, Walter, Iona, Brighton, Eumelan, and a long list of similar varieties can often be grown in perfection, though seldom in the hands of a novice.

A long list of new and promising varieties is now coming forward for trial, many of which will carry disappointment with them. Many vines will be propagated from feeble, immature wood, and will be practically worthless; reject all such; don't pay $2, $3, or $5 for a shadow. Remember that the success of any variety, of foreign parentage, is very questionable, with the probabilities strongly against it. Grape-growing has charms that should engage your best study, closest attention, and highest skill.

THE STRAWBERRY.

This is our first fruit in order of ripening, and among small fruits it justly takes the first place. The culture of the strawberry as a field crop to supply the markets of the country, is an enterprise dating back to a period within the memory of persons now living; yet it has assumed an importance not dreamed of by those who commenced in a small way to grow strawberries for market. Fifty years ago hardly known as a market commodity, it is now reckoned in value by millions of dollars, seventy-five tons going over a single railroad in one day to market is not now a strange thing. During the strawberry season nearly every avenue of travel and traffic is crowded with strawberries going to the great metropolis, New York. Thousands of plats of this delicious fruit are found all over the country, from the little garden patch up to the two hundred acre strawberry farm of Norfolk, Va., and strange to say, nearly the entire amount is quickly used up by the great army of consumers. Half a century ago this would have been regarded as a foolish and wicked outlay for a needless luxury. Now it is justly and truly regarded indispensable as a sanitary provision—indeed, a necessity—

bringing as it does bloom and vigor in place of pallor and debility.

At a meeting of the Michigan Pomological Society some years since, a gentleman past the age of ninety rose and forcibly addressed the meeting on the sanitary effect of summer fruits, giving his own experience as an illustration. The salutary effect of well-ripened fruit is everywhere acknowledged by the medical faculty; its use is encouraged in the hospital and the sick-room; it is found good not only in continuing but in restoring health. No wonder, then, that it has ceased to be a mere luxury and has become a necessity.

It is an economic question, then, "How can we best obtain a supply?" Those who raise small fruits for the market are of course glad to supply you through your dealer, who is also desirous of the trade. This is all well; still there are many waste corners in city and village yards and gardens that might be put under contribution in giving rich supplies of choice fruit, and under the management of deft fingers become at once a source of health, interest, happiness, and economy.

From close observation through our State I fully believe that not one family in ten has an adequate supply of small fruits through their season. There has been great improvement in this respect, still we are far below an adequate supply.

Farmers, this is worthy of your serious consideration. As soon think of going without milk or butter as to forego a full supply of the best strawberries, they can be so easily raised and so heartily enjoyed.

A very important matter in connection with growing any kind of small fruits, or any other fruits,—but specially small fruits,—is to have *a good stock* as the foundation from which to start. The strawberry is easy to intermix; it is easy under careless hands to degenerate. We have several times suffered severely in this matter, so we give a word of caution. Suppose you wish to plant the "Charles Downing" strawberry. Get the stock from some grower who runs that variety in *the full tide of perfection.* Get choice, select plants, strongly rooted and full of vigor; let your propagating bed be on land that is in excellent condition; keep it in its best state, and you will have plants full of promise for abundant fruitage.

On the other hand, suppose your plants are sent from a spent, degenerate stock, even though pure in kind, you have an imperfect set and inferior fruit, entailing disappointment and loss. All strawberry growers, and especially all strawberry propagators, should be particularly careful not only to have a pure stock but also to have *an improved stock* of plants. To do this there must be an *exalted ideal*, which should be persistently followed.

For accomplishing this, suppose we take the Sharpless as an illustration—the habit of the plant is good. Now in blooming time go over your plat and select 200 plants that, taking all the points in view, seem the best in your field of 10,000 plants; set marked stakes by those 200 plants when their fruit is sufficiently set and developed to show the form and productiveness; take the best 50 out of the 200 marked plants, remove carefully all the fruit and set in a good propagating bed as a stock bed. We think a selection of plants thus made, year by year, would be grading up instead of down as is so often the case. Now with the Sharpless again its great fault is its irregularity of form; by a judicious selection of plants this fault may be partially corrected. So with other varieties: if by a proper selection of plants we can choose the most vigorous, most productive, best formed fruit—in short, if we can choose the good points, and eliminate the bad ones, we shall be making progress in the right direction. We commend this consideration to all practical strawberry growers.

CULTURE OF THE STRAWBERRY.

Choose land which is capable of producing seventy-five or one hundred bushels of shelled corn per acre, or two hundred bushels of potatoes. Let it have three years good clean culture, and be well enriched each time; let all stones be removed; if so situated that it can be irrigated by a running stream, all the better.

Plow as early as the ground is in good condition; after plowing top-dress with 500 lbs. per acre of Leopoldshall Kainit, 400 lbs. bone meal, and 300 lbs. Peruvian guano; let these be well mixed in the soil, with a wheel-harrow; then plant out in rows, 3 ft. by 18 in. in the row for hill culture, or 4 ft. by 2 ft. for matted rows.

Let the ground be cultivated with the French cultivator, and hoed after, until the frost stiffens the ground. We would not attempt to mention the number of hoeings, but they should be frequent and thorough.

There are strong reasons in favor of hill-culture, and we are inclined to favor that system if the land is free from grubs, even for the commercial grower, choosing those varieties adapted to that system, such as the Duchesse, Duncan, Wilson, Monarch, Pioneer, Jucunda, Durand's Beauty, Champion, Chas. Downing, Seth Boyden, Sharpless, and the like, while the Crescent, Green's Prolific, Downer's Prolific, Capt. Jack, and that class which throw runners profusely, would require too much time in keeping off runners.

If the land be very clean after the crop has been gathered, the mulching put on November previous can be raked off, the foliage all clipped off, the ground well cultivated and successively hoed for a crop the next year: whereas if the grass and weeds have come in, by all means turn them under and replant in hills as before.

VARIETIES.

Wilson—Productive, early, a good shipper, sour, runs small at last of season.

Chas. Downing—Fairly productive, excellent, holds out well to the last.

Seth Boyden needs high culture, sometimes very productive, very good, sells well, but neither this nor the Downing equal the Wilson in firmness.

Duncan—Well suited for hill-culture, productive, excellent for a near market.

Duchesse—One of the best early berries; well suited for hill culture.

Durand's Beauty throws very few runners; a splendid berry for family use, productive and excellent, needs high culture.

Great American—Does not flourish on a dry soil, on a heavy soil excellent; brings high prices.

Sharpless—Promises well, a strong plant, good quality, not sufficiently tried.

Black Defiance, Denning's White—Excellent amateur berries, neither suited for market.

Green Prolific, Downer's Prolific, Crescent—All productive, soft, fit for only a near market or family use.

Crystal City—The earliest, not well tried.

Kentucky—A good late berry.

Glendale—A still later berry, good.

Longfellow—A new variety from Kentucky, firm, late, not well tried.

Black Giant—A very promising, large, dark berry, a good grower, firm, promises to be a good market variety.

Miner's Great Prolific promises to be one of the *best*, not yet well tried.

Triomph De Gand—An old foreign variety of best quality, wants high culture.

There are numerous varieties, but all have their faults.

The Forest Rose is excellent, but rusts badly. So one has this fault, and another has that; we have not yet a perfectly good production.

SHIPPING BERRY.

Let some one take the Wilson in its best state and cross with Triomph De Gand, bringing out the best points of both without the faults of either, and he will be entitled to go to the head. Amateurs, try your hand at hybridizing.

THE RASPBERRY.

This fruit, like the strawberry, is delicious, healthful, and nutritious, and to a certain extent profitable for market. Every family owning a garden should have a home supply.

The blackcaps are perfectly hardy in our climate, the early varieties being the Doolittle, Davidson's Thornless, and Seneca Blackcap; the later ones Mammoth Cluster and Gregg.

The Gregg is probably the largest and best, but it comes late like the Mammoth Cluster, so as to compete with the whortleberry in market, which is against it; however, it is none the less delicious as a table berry.

Among the red varieties, the Naomi, Philadelphia, Clarke, Herstine, Highland Hardy, Cuthbert, and Turner are the most desirable, but of all these perhaps the Turner and Clarke are the only ones really hardy so as not to need protection. The Turner appears to be entirely hardy, quite productive, and though not firm enough for long shipment, is good for a near market. The great objection to the Turner, as also to the Thwack is, it suckers so freely, but with proper management the suckers can easily be kept down.

The soil for the Raspberry should be a good, strong loam, heavily manured, and kept in good cultivation, in which case the yield of choice fruit will be heavy.

BLACKBERRIES.

The Snyder is perhaps the only variety which is perfectly hardy, although the Taylor is nearly so, the Dorchester and Kittatinny are of good quality, but sometimes winter-kill; Wilson's early is a fine fruit but liable to winter-kill. The Snyder is thought to be *iron-clad*, is productive, though smaller than some other varieties, and of very good quality.

The attention of Connecticut orchardists is urged to the consideration of the best way of keeping surplus winter fruits; and of adopting some good fire-heat fruit dryer, to save the surplus of summer and autumn fruits that have so often gone to waste; the benefit from a general practice of prolonging the season of winter fruits would be a great advantage to the producer, and no less advantage to consumers.

The merit of a general saving of the thousands of bushels of autumn fruits by drying, would be, First, to secure better prices for what the market demands, and a much steadier market; Second, to save absolutely vast quantities of fruit that would otherwise inevitably be lost both to the grower and to the consumer.

The importance of these considerations is evident at a glance.

ANSWERS TO QUESTIONS.

How shall we destroy the aphis which infests our cherry trees?

Ans. First whitewash the trunks and all the long branches well up, in April, with a whitewash in which one pint of carbolic soap to the gallon of limewash has been well mixed. If the aphis appear, as some probably will, drench the trees on their first appearance with carbolic soapsuds, as warm and as strong as can be used without injury to the leaf; if very strong rinse off thoroughly an hour after using; *repeat* if necessary.

What do you advise about setting the quince? The quince is profitable under certain circumstances.

1st. The soil and location should be favorable. The soil should be deep, rich, and a little moist. The trees should be thrifty; I prefer those in the bush or shrub form; orchard experience is conclusive in favor of this form. When well started use soap freely in May to prevent the attacks of the borer. The quince roots near the surface, so only shallow culture should be given.

Exhibit of Fruits at our Agricultural Fairs.

No more gratifying proof can be given of the very general and increasing interest in fruit culture than the beautiful exhibitions of fruit at the various town, county, and state agricultural fairs. Notwithstanding the year has been comparatively a barren one, the show of fruits almost everywhere has been excellent. Especially has this been the case with pears, and in some instances with grapes and other fruits. The exhibit of apples, though less extensive than in 1878, has been very good; and as a whole the exhibit of fruits at the State Fair in Hartford, and at the County Fair in New Haven, would compare favorably with any in the country, if we except Boston, Utica, Rochester, and the State Fair of Michigan.

Exhibit of Fruits, Grains, Corn, Vegetables, etc., at the Winter Meeting at Willimantic.

Owing to the scarcity of fruits in Windham County, there was not as large an exhibit as on some previous years.

Secretary T. S. Gold, as usual, showed a very choice selection of apples, 27 varieties; also 3 varieties of pears.

P. M. Augur & Sons, 14 of apples and 3 of pears.

A. D. Capen, Esq., of Boston, 8 varieties of pears.

C. T. Hickox of Watertown, member of the Board, 8 varieties of choice apples.

Mr. Perkins of Willimantic, Roxbury Russets of 1878 and 1879.

T. S. Hubbard of Fredonia, N. Y., exhibited a choice dish of Prentiss grapes, very fine in quality, and while the grape is as early as the Concord, or perhaps a little earlier, the grapes were in good condition at date of meeting, December 16, 17, 18.

Hon. Albert Day of Brooklyn exhibited 4 varieties of potatoes, including the Burbank Seedling, Early Ohio, and Bliss' Triumph.

Mr. Williams of Mystic, White Flint and Georgia flouring corn.

Mr. J. B. Olcott of South Manchester, a barrel of Tuscarora corn for distribution, and meal of the same to show the farmers what a choice meal that variety produces. Mr. Olcott's meal was very nicely put up in paper bags, labeled, and was found on trial to be of best quality.

Mr. N. Platt of Cheshire exhibited Tuttle apples and Sweet Greenings.

Messrs. Hale of South Glastonbury showed a nice collection of several varieties of preserved strawberries, which attracted much attention.

Much credit is due to Mrs. Clark, the florist, of Willimantic, for a choice collection of plants.

There was also on exhibition a choice article of sorghum syrup from Messrs. Charles W. Marsh and William R. Andrews of Mansfield. Also samples of sorghum sugar and sugar made from cornstalks, by Prof. Collier of Washington, D. C., pronounced very good.

Much credit is due in all the management to Mr. Hooper, janitor of the Hall, and also to Mr. Perkins, president of the Willimantic Farmers Club, for generous aid.

REPLIES TO QUESTIONS ON FRUIT.

J. H. Hale, Elm Fruit Farm, South Glastonbury. As by request in your circular giving notice of meeting of State Board at Willimantic, I will give you a short report of the methods used, and results, in small fruit growing at Elm Fruit Farm. I begin with strawberries, of which we cultivate from ten to twelve acres, usually setting them on ground that has been under cultivation for two or three years, as there is less danger of white grub than if set on sod ground. In making large plantations we set as early in the spring as it is possible to work the ground, generally from the 1st to the 15th of April, although we have set them as late as the last of May, and had a fine growth of plants; but our rule is, just as early as possible. Have also had good success with potted plants set in August or September; in fact, if we want extra fine fruit we look for it upon our summer or fall set plants. Our soil being mostly a sandy loam we usually plow in the spring, after which we apply about 2,000 lbs. ground bone and one-half ton of muriate of potash (or its equivalent in wood ashes, when we can get them), per acre,* and work in thoroughly with a wheel-harrow, then with rule and line mark off rows six feet apart, and set plants one foot apart. Commence hoeing in about ten days, using a cultivator between the rows; continuing the hoeing and cultivating once in a week or ten days until the ground freezes in the fall (we finished hoeing this fall on November 22d). We allow each plant to make all the runners it will, letting them run out each side of the row, and by narrowing the cultivator each time, at the end of the season it leaves matted rows or beds four feet wide, with walks two feet wide between them. Besides bone and potash, have used stable manure, Peruvian guano, dry fish, and Stockbridge strawberry manure, but after several years' trial find we get the best results at much less cost by the use of the bone and potash. As soon as the ground is frozen in the fall we apply a mulch of some kind to the whole surface of the ground—hay, straw, or coarse stable manure—taking care not to get it so thick as to smother the plants, and yet thick enough to shade from the sun during the warm days of February and March. Do not remove any of the mulch in spring, as it helps to keep the ground moist and the berries clean through fruiting time; it also serves to keep them back a little and they do not ripen quite as early, which is quite an object with us, as we do not care to get our fruit into market until the rush of southern berries is over. Our picking season usually begins about June 1st and lasts about five weeks, although now that we have such fine late varieties our family supply is prolonged two or three weeks. Our berries are all picked between 4 and 10 A. M., as we find they keep much better than when picked in the afternoon after they have become heated. The price paid pickers is from 1½ to 2 cents per quart, mostly the former price. Use the American square basket and pack in 32-quart crates. The average yield per acre the past season was 2,870 quarts (being much less than usual on account of frosts in May which destroyed three-quarters of the blossoms). Highest price 50 cents per quart for Pioneer and Black Defiance; lowest 10 cents for small Wilsons; average through the season for all varieties 19½ cents, wholesale. Have from 50 to 60 varieties; as our business is largely that of shipping plants to every State in the Union, we are of course obliged to test all new kinds as fast as introduced, and as might be expected find many not suited to our soil and climate. Of the well-tested sorts I would recommend as the four most profitable for market, Crescent Seedling, Champion, Wilson, and Downing; for family use, Black Defiance, Monarch, Downing, and Kentucky. Of the new the most promising for market are Glendale, Windsor Chief (claimed by some to be identical with Champion), Marven, and Sharpless; for family use, Lincoln, Sharpless, Pioneer, Cumberland, Triumph, and Miner's Prolific.

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* Unless plowed in or worked in very thoroughly this would prove too heavy an application.

Raspberries, both red and black, are cultivated. Manure the same as for strawberries. We plant blackcaps five feet apart each way and tie to stakes four feet high: cut out the old wood as soon as they have done bearing in the summer, tie the new canes to the stakes and head them back to about four feet, cultivate and hoe until ground freezes—give no cultivation in the spring.

Red varieties we plant in rows seven feet apart with plants one foot apart in the row, allowing them to form a hedge, pinching them back when about three feet high; cut out the old wood and cultivate same as blackcaps. Yield per acre the past season, about 1,000 qts. of red and 1,400 of blackcaps, highest price per qt. for red, 35 cents; lowest, 20 cents; average, 26 cents. Blackcaps, highest 20 cents for Gregg, lowest 10 cents for Mammoth Cluster, average, 16 cents; price paid for picking, 2 cents for blackcaps and 3 cents for red. About 20 varieties are cultivated, the most profitable being Brandywine and Turner, reds, Doolittle and Mammoth Cluster, blackcaps; of the new varieties the most promising are Cuthbert and Queen of the Market, red, Caroline, yellow, Souhegan and Gregg, blackcaps.

Gooseberries are grown to some extent and found to be very profitable. Plant four feet apart each way, keep them trimmed very close, cutting back each fall about two-thirds of the new growth, besides thinning out. We grow only Houghton, Smith's Improved, and Downing, the latter being the most profitable. and Smith's Imported, the best for table use; yield, 5,000 qts. per acre; price per quart, 12½ cents.

Currants are only grown for family use and to get cuttings to propagate plants from, as our soil is not suited to them. The varieties are Cherry, Red Dutch, White Grape, and Le Versailles; Le Versailles and Red Dutch being the most profitable.

Blackberries are cultivated some, but mainly to propagate plants from, and for family use, as they are not found to be very profitable on account of late ripening. They have to compete with markets full of peaches. Cultivate and manure the same as for raspberries. Eight sorts are grown, Wilson's early being best for market, and Kittatinny and Snyder best for family use; the latter (although the fruit is of only medium size,) being particularly valuable in our climate on account of its extreme hardiness and great productiveness.

In closing this report, I would urge upon the farmers of Connecticut the importance of having a full supply of small fruits, at least for their own tables, and if near a good market they will help to swell the yearly income. ½ acre devoted to berries will give a family of six persons an abundant supply, three times a day, for three months, and besides lessening the expenses, will usually save twice its cost in doctor's bills. 20 rods planted with 6 varieties of strawberries, 1 early, 3 medium, and 2 late, will give on an average of 10 quarts a day for six weeks. 15 rods of raspberries, 3 varieties, red, black, and yellow, which begin to ripen before strawberries are gone, will give a supply of at least 8 quarts a day for four weeks. 5 rods of gooseberries should yield 100 quarts of fruit, that can be used at any time from June 20th to the first of August, for making pies, tarts, and for canning. 15 rods of currants ought to supply five quarts a day for four or five weeks; and 15 rods of blackberries, if early and late varieties are planted, will give five or six quarts a day for about six weeks. The remaining 10 rods can be used for walks, etc. The first cost of plants for such a plantation need not exceed $25, after which the only cost would be for the yearly manuring and cultivation, which would not be over 3 cents per quart for all berries used in the family; and when I think of the many farmers that annually pay from 15 to 25 cents per quart for a few stale berries once or twice a week through the season, it is a mystery to me that all are not supplied with a family fruit garden.

L. W. Crouch, Quakertown, Mystic P. O.—About twenty acres of strawberries, nearly all Wilson's Albany, have been cultivated in this vicinity the past season, and it is probable that most of the fruit will be marketed at Norwich, as it generally is, every year. I commenced the cultivation of small fruits five years ago last spring, set at that time half an acre of strawberries—varieties, Wilson, Col. Cheney, Early French, and Kentucky. Of raspberries, Mammoth Cluster, Golden Thornless, Davidson's Thornless, Philadelphia, and Kirtland. Blackberries, Kittatinny, Early Wilson. I had but little manure at that time except fish scrap, so I plowed in of that 5 tons to 1½ acres of ground, before setting my small fruit plants; sorrel came in abundantly, but the plants made but little headway. After much labor in fighting sorrel, I succeeded in getting a fair crop of strawberries. Stable and hog manure was applied the second season, when the raspberries and blackberries began to do well. Since then I have tried some other varieties of strawberries, such as Chas. Downing, Boyden's No. 30, Metcalf's Early, Downer's Prolific, Champion, Sterling, Monarch of the West, and some others; raspberries, Ganargua; blackberries, Dorchester and Snyder. Have tried quite a number of different kinds of fertilizers, and have had the best results with strawberries when I used hog manure, wood ashes, and bone dust; stable manure for blackberries and raspberries.

After trying different methods of culture for strawberries, I have settled on the matted row system, not allowing the beds to get over two feet wide—18 inches is better—with the same width for paths between them. I keep the cultivator going until they begin to run, then cultivate by hand, and let them cover the ground all over, as I want plants to sell as well as fruit. I cover with fine brush which is cut when the leaves are on, and it is the best winter mulch I have tried. About the first of April, or as soon as the frost is all out of the ground, I commence to take off brush and take up plants. Stretching a line, leaving a bed 18 inches wide, I use a potato digger or prong hoe and take up plants by the line, making a path about 18 inches wide; when the rows are long, I use a strong cord with a sharp stick about two feet long at each end. When only fruit is wanted it is best to cultivate by horse power the whole season, narrowing the cultivator as the vines run until the paths and beds are of the right width, and pull the weeds out of the beds by hand. I use a small hoe about 4 inches long, 1½ inches wide, sharp corners, and very thin, with a handle about a foot long.

In setting strawberry plants I set some varieties thicker than others. Wilsons or Sterling should be set about one foot apart in the rows, and rows three feet apart, while the Kentucky, Downing, Col. Cheney, Monarch, Capt. Jack, Crescent, and Glendale, and many others I might mention, need not to be set thicker than two feet in the rows, with rows three feet, and will always make plenty of vines with me unless the worms eat off the roots. I set last spring a little more than one and a quarter acres, mostly Kentucky and Charles Downings, two varieties that I consider the most profitable for me of any I have proved thoroughly. I have some small beds of the following varieties, which were looking well when they were covered, though they have not fruited with me yet: Capt. Jack, Glendale, Sharpless, Crescent, Duncan, Prouty, and Nicanor. I have a very good opinion of them from the looks of the vines. I have also a nice bed of seedlings which I originated from mixed seed of nearly all the varieties I have cultivated. Col. Cheney did well the first two seasons, after that the fruit was too gnarly, and did not ripen well. The quality of the Sterling berry is the best I have seen, but they are too small after the first two or three pickings, and the plant is too tender and subject to the blight. The Champion is an enormous yielder, plant quite healthy, but the berries are soft and sour. The Monarch is profitable with high cultivation, unless the frost kills the blossoms, as it did with me the past season. The blossoms stick up too high above the leaves with nothing to protect them; not so with Kentucky and Charles Downing. Early French is sweet and quite early, but too soft for market. Downer's Prolific is the most profitable early sort. The good and bad qualities of the Wilson are too well known to need any comments from me. It has been so badly affected with blight the past two or three seasons that I set but very few last spring. Have never failed of getting a good crop when I set Kentuckys or Downings. I generally make my last picking from Kentuckys about the middle of July. Downings ripen about the same time with Wilsons. I have always received an average of five cents a quart more for Downings and Kentuckys than for Wilsons.

Mammoth Cluster raspberries are very large; plant productive and hardy, but late; ripens at the time when the market is filled with whortleberries. Davidson's Thornless are earlier and more profitable. Ganargua will bring the highest price of any kind. I have not proved them enough to know whether they will stand our winters. Golden Thornless is a very hardy bush and a good yielder, but the berry is very far from being golden, but is a dirty yellow, and not very good flavor, so it does not sell well where it is known. Philadelphia and Kirtland are both claimed to be very hardy, but not so with me; they have died down to the ground nearly every winter; have plowed them all up.

The Snyder blackberry is the only kind I have tried that is sure to stand the winters. It comes out alive to the tips every spring, when other varieties are badly hurt or killed to the ground. The Snyder is a good yielder; berries are rather small, but will make up for that in quantity and quality.

When I see any rust on blackberry or raspberry plants I cut and burn them; am not troubled with it very much. My land is nearly level, situated on a high hill in a very windy place; sometimes the bushes are badly broken down or limbs broken off by the winds. They are injured the worst in summer when the leaves are on.

White worms and sorrel are the worst strawberry enemies I have to deal with. The best things I have found for these are salt for the worms, and elbow-grease and sunshine for the sorrel. Salt should be applied in the fall or winter, at the rate of two barrels to the acre, on land that is to be set to strawberries the next spring. I have a nice bed of Kentuckys, from which I have picked four crops of fruit. The land has been well salted, the first application being made at the time they were set. The worms have troubled them but very little.

Dwight B. Campbell, Griswold. "I have come to the conclusion that the Charles Downing is the berry for this locality, after six years of experience. Find strawberries, like every other business, has its ups and downs; sometimes the hard winter kills them, and sometimes the grubs. Apples are plenty the bearing years. Pears are plenty and are becoming more so, as many trees are being planted every year. Peach trees are short lived. . . . . With a fair season the town of Griswold is well calculated to yield a bountiful supply of fruit."

James Allyn, Montville. "Muskingum Pear. The original tree is on the farm of Hon. Erastus Geer. I think it better for our climate than any other late summer and early autumn pear."

John Plant, Branford. The Wilson has rusted badly of late: dislike to give it up unless can find something better. Is the Windsor Chief a good shipper? *Ans.* Same as Champion. How with Black Giant? *Ans.* It promises well.

J. S. Collins, Moorestown, N. J., President of New Jersey Hort. Society. I marketed something over 88,000 quarts of berries during the past season, nearly one-half of which were strawberries, and of these the larger part were Crescent Seedlings, and all were grown in matted beds, manured the previous winter broadcast with stable manure carted direct from Philadelphia. The Crescents were mostly knotty from imperfect impregnation, not being sufficiently mixed with other staminate sorts. There were probably more Charles Downings fruited hereabouts last season than any others; nice berry, but sometimes is affected by a sort of leaf rust that comes on in foggy weather, and sometimes not until almost time for ripening. Continental; fine, healthy sort, good quality, late; I guess would pay well to raise in Connecticut; would come into New York market after Jersey berries were done, or nearly so. Wilson's Albany are more raised on sandy soil in west and south Jersey than any other as yet, but are giving way, at least for the present, to the Crescent. All, or ninety-nine per cent., are raised on bed system. One plantation at Gloucester, N. J., of Boyden No. 30, in hills, and irrigated, has been a success for a number of years; produced large berries and brought high prices. Miner's Prolific made a fine show in all cases on small scale. Sharpless; berries large but not prolific, I thought. Of raspberries, Brandywine were most raised;—Queen of Market or Cuthbert, being stronger growers, may and will likely take its place to a great extent. Reliance is best of all, except too dark colored to sell freely in wholesale markets.

C. M. Parsons, Sandy Hook. Apples, yield very small. . . . On the low land, where the frost destroyed the blossoms the previous year, the yield was much better. . . On my farm last year all varieties bore heavily; this year the Northern Spy, Russet, and Ox varieties bore well, but the fruit was smaller than last year. The warm, moist days of November caused my apples to decay badly. The Greenings, Porter, and Baldwins yielded poorly this year; Greenings specially a failure,—none fit for market.

For three years the currants have been destroyed by the currant worm. It is tedious and provoking work to keep them from destroying the foliage and fruit.

The grape rot affected my Concords badly this year, and last spring I dug in ashes about the vines. The grape crop was heavy about here, and more wine was made in 1879 than for five years preceding.

I became interested in the Crescent Seedling strawberries two years ago, and ordered a few plants for trial. The ground was fertilized with hen manure, and the plants set in the spring. The following year the yield was large, but the berries somewhat inferior in size, and would not keep long; therefore it would prove a very poor kind to send to market. I have not given up this variety yet, as I wish to test it still farther. The growth of the plant is strong, and rapidly covers the ground. I let the plants mat, as I think it keeps the fruit cleaner, and helps to keep the birds from finding the very largest of the berries. A path is kept on each side of the plot, the bed being about three or four feet in width. There is great saving of time in raising strawberries in this way, but it is not the way to have large ones. The Crescent will not rank among the first, when people have had a chance to see for themselves. As I have had a short experience with this variety, perhaps I ought not to speak disparagingly of it, but certain dealers have represented the variety to yield so enormously, and to be the best for market of any variety known, that one's experience will teach him to judge for himself, and not depend too much upon the representations of another.

D. H. Van Hoosear, Secretary Wilton Farmers' Club, and Members, (condensed). Apples extremely scarce, especially cultivated kinds. An occasional wild tree bore abundantly. Pears abundant, and I did not realize that the flavor was insipid, as is the general complaint, except the Vicar of Winkfield, which is worthless, and has been ever since I knew it. Most of the Club ripened Flemish Beauty without cracking. I would plant largely of Lawrence, Belle Lucrative, fine; Dearborn's Seedling small and rotted; Bartlett reported as inferior to usual quality.

Grapes—leaves curled, and fruit rotted; Isabella generally a failure; had some rose bugs. We are anxious to know more about Moore's Early. Brighton is recommended in its place at less cost.

Cherries a general failure. Plums given over to curculio.

In our strawberry exhibit were some fine specimens of Monarch of the West, Boyden No. 30, and Sharpless, evidently well cared for. Crescent yield well, but are a little sour, and if not fertilized has deficient, sided berries. Great American discarded.

A suggestion to aid peach culture. • You tell us if we could get trees grown from pits from Tennessee or Southern States, we would not be likely to be troubled with yellows. One of our club said he would pay well for pits from South Carolina if he could get them, and I was thinking why couldn't the State have a peach nursery "true to pit," and sell at or near actual cost, from pits grown South, or furnish pits in sand to applicants at or near cost. If this could be done it would help peach culture. The nurserymen claim to have the same, but you know how it is—to sell.

NOTE.—We think there is no class of men who take so much pains to insure accuracy, sound, healthy goods, as the nurserymen, and we want to hold on to this faith. T. S. G.

J. W. Adams, office of the Brightwood Nurseries, Springfield, Mass. In complying with your request I am obliged to omit that part referring to the "amount" harvested in this vicinity, having no record at hand. There has been a general increase in the quantity, and corresponding improvement of the quality, of strawberry crop. Market gardeners affirm that the demand for varieties of excellent flavor indicates that much larger quantities of the superior sorts may be sold in all our large towns and cities. Growers are divided in opinion as to which are the best, but several are agreed upon the following points:

The Sharpless may be set down as the largest of what may be called the productive sorts; and it will be one of the best to be grown in hills.

The Crescent appears to be the most productive, and it is rapidly superseding the Wilson, as a market variety. The quality is good.

The Kentucky is a large, late, and quite productive berry, holding its size to the last picking.

The Glendale is a new and promising, late sort from Ohio. Miner's Great Prolific is popular. Col. Cheney generally does well. Monarch has produced a large crop of very large fruit in one instance only. Most of the growers condemn it.

The above list may be taken as the best of the thirty sorts on trial.

Blackberries are generally discarded. Black raspberries are grown by several, and the Mammoth Cluster is generally considered the best. Agawam, a new thornless variety, is praised by one grower for its vigor and large size.

The Concord grape still heads the list, and it is pretty safe to say it is of more value to the community than all the other sorts combined. The Worden is superior to it in size, flavor, and earliness. It has not the vigor, however, but we hope it will prove, as it promises to be, a very valuable kind. Nearly all of Rogers' Hybrids mildew more or less. As a class, they are of very little value. The Hartford is a vine that every homestead should have; but the Champion should not be admitted except for its earliness, and then only as "a single individual." The Creveling does finely with me; but the Delaware and Diana are both tender-footed, while the Iona produces a few bunches that are of sugary sweetness, and keep later than other sorts.

We cling to the Early Amber as always early and very good. The Senasqua surprised us once by its immense bunches of fruit, and its failure to leaf out and grow since that event. The Brighton is a favorite, but the Croton is not, and the Israella is banished.

Of the best method of pruning, to get large and fine clusters, try to send all the sap into one shoot this year, and in February cut off all the others, leaving one cane only, and that one may be cut back to four, six, or eight feet, according to its strength. If this practice is adopted, another cane must be brought up annually; the idea being to get the strongest new wood. A larger top will, we think, produce more pounds, and will have a greater following. The larger bunches find a more ready market, at tempting prices.

What will be the effect of not pruning at all? Those who read the report of the American Pomological Society for 1877 may have noticed our reference to a Concord vine, planted in 1868, and which took possession of a good-sized apple tree, and was allowed by us to grow at random. The product was there stated to be by estimation three thousand clusters. Last fall it was examined by a gentleman who had traveled the world over, having visited, in harvest time, the vineyards on the Rhine, as also those at the Cape of Good Hope. He pronounced it the most wonderful exhibition he had anywhere seen. The crop was about the same as in 1877. The effect of such a burden of fruit was to make it several weeks later in ripening.

Of insects on apple and pear trees the most troublesome is the white scale or bark louse. A wash of strong potash destroys them with one application. I have never known it to injure a young tree, but some prefer to wash such trees, within a half hour after its application, with clear water. Canker worms have never visited this section of Massachusetts, and orchardists are not anxious for a privilege to sprinkle Paris green upon their leafy food—a remedy that has proved to be immediately effective in their complete destruction. The blight that is so commonly seen in western New York on the twigs and limbs of apple trees has never been noticed here, and the more destructive blight to pears in the West has not been much noticed here until the summer of 1878, and yet less last year. Reports from Maine state that they are exempt from that malady, and there are horticulturists who affirm that we were comparatively free from this disease, and that our success was greater, especially in the department of dwarfs, while we imported the bulk of our trees from France. In other words, the cause being unknown, has it not been brought here like the cattle plague from the West, and, when here, is it not contagious, and does it not spread from tree to tree?

Our faith that it is a fungus that microscopic investigation will yet explain, so that a practical remedy may be applied, is strengthened from the fact that some sorts, as the Glout Morceau, and Swan's Orange, are very susceptible to this disease, as all the Russian apples are seized upon by the bark scale, while some varieties escape. This is one example where the better sorts are more exempt from diseases than the inferior. Another case is in the Seedling or crab pear, which always suffers with the leaf blight, causing all their foliage to drop before the 10th of August, while the finer varieties, as the Bartlett and Anjou, continue to grow until October.

If this report were not already too long, suggestions might be made upon varieties of larger fruits, and a local list written out and explained. Perhaps you have noticed that we always have too much fruit in the month of September. How few can bring out a nice dish of Lawrence pears at Christmas! There is room in this direction for young men in New England to show their zeal in a direction where the cost shall not exceed the compensation, but with the gain to themselves they will greatly promote the public good.

REPORT OF THE COMMISSIONERS ON DISEASES OF DOMESTIC ANIMALS.

Your committee have to report that not only by the actual presence of pleuro-pneumonia in the State have their labors been largely increased the past year, but the fear of this malady has made our farmers more watchful, so that we have been very frequently called upon to investigate cases of disease, thus often to quiet the fears of those who may have had animals suffering under some casual ailment.

The only cases that would seem worthy of notice in this report are those of pleuro-pneumonia, bone-ail, catarrhal fever, tuberculosis, and glanders.

PLEURO-PNEUMONIA.

January 17, 1879, your committee were informed that a fatal disorder existed in a herd of cows in Watertown, belonging to Curtis Judson of New York city. We visited the herd that evening and gave the opinion that the herd had pleuro-pneumonia, but called Dr. Cressy for further examination, when our diagnosis was confirmed. The history of this outbreak of the lung plague is so interesting that we give it somewhat in detail.

On our first visit we found that in a herd of nineteen choice cows two had died and many of the others were sick. A week later, when we called Dr. Cressy in consultation, two more had died, and one in the advanced stages was killed for examination. The appearance of the lungs in this animal, as well as in those that had died, confirmed our opinion that we had here the fatal contagious pleuro-pneumonia or lung plague. Portions of the lungs were much enlarged, of a cheesy character, with pleural adhesions. The posterior lobe of the left lung of the cow killed weighed 25 lbs. High fever, shown by a temperature ranging from 101° to 107°, the normal temperature being 99°, hurried respiration, and a frequent cough were the most obvious symptoms. We quarantined the herd upon the farm and prohibited them from sending milk to New York. The most natural inquiry, where did the disease come from? elicited the following facts:

In August, 1878, Mr. Judson purchased two cows in New York and sent them to the farm. In October one of these cows was taken sick, and not long after others sickened with the same complaint, and two died previous to our visit, January 17th. These New York cows brought the infection into the State, and Mr. Judson, soon after our last visit, desirous to rid his farm of the plague, sold the remainder of his herd, eleven in number, having lost eight with the one killed, to Jacob Hecht, the broker of whom he bought the cows in New York, or to Abraham Stern. On Saturday, February 8th, they were shipped to New York in a closed car by the Naugatuck and New York & New Haven railroads. Your commission being informed of the shipment met and identified the cattle at Bridgeport, and preceded them to New York.

The proper authorities being informed, the cattle were seized at Harlem River by Inspector Dr. J. E. Comfort of Morrisania, placed in the cattle pound, and examined by Dr. Liantard of the New York Veterinary College, and Dr. James Law of Cornell University, who was in New York, acting under a commission from Gov. Robinson to investigate the disease in its old haunts, the swill-milk stables of Long Island. They decided that most of the herd were suffering with pleuro-pneumonia, while all showed some symptoms of it. Under an order from the Board of Health the whole herd were slaughtered, with the privilege if any were found sound on slaughtering they might be sold for beef, otherwise they were to go to the offal yard. The whole herd were found diseased, and condemned.

The favorable condition of isolation of the herd of Mr. Judson prevented the spread of the contagion, and as no other cases have occurred in the vicinity within the knowledge of your commission, we consider that source of contagion extinguished.

March 19th your commission visited North Greenwich, being informed of the existence there of fatal cattle disease. We found a herd of cows on the Sands place in charge of

Brokaw L. Mead, from which five had died and ten others had been sick, eight having lost their calves prematurely. In a post-mortem of a case recently dead we found clear evidence of pleuro-pneumonia. At this time D. M. Griffin, on the adjoining farm, had lost two cows and had one other sick, and others had symptoms of the disease. Since then the disease has extended in the herd, and Mr. Griffin has lost eight head. These farms are situated on the New York border, Mr. Mead's farm extending into that State. We quarantined both these herds on their own farms, and prohibited other cattle from running in the adjoining highway.

On the recovery of these herds we have allowed them; with the consent of the authorities of the State of New York, to be sent to New York for slaughter, and we are not aware that there are now any acute cases of the disease in Greenwich. How did it get there? A calf sent from New York about Sept. 1, 1878, to be raised—to the farm of Mr. Mead—died, and it is supposed to have brought the disease. The cow that suckled it was taken sick and died about Nov. 5th. Several cattle were reported to us as having died in Greenwich during the winter, and we called Dr. Cressy to make an examination, particularly of the herd of Abraham Reynolds, but we failed to detect the presence of pleuro-pneumonia in this herd or anywhere else in Greenwich, except in the two above named.

Co-operating with the New York State Cattle Commission, which, in its efforts to circumscribe and extirpate the disease, forbade the transportation of cattle northward and westward from Putnam and other infected counties, your commission, March 28, 1879, forbade the bringing of cattle into this State by rail or boat from Long Island or the counties of New York, Westchester, and Putnam, which prohibition is still in force.

At the request of the New York commission we have kept careful supervision of the western part of the State for any infection, and we are happy to be able to report that so far as we can ascertain the lung plague does not at this time exist in the State in the acute form, but has been entirely extirpated. The history of the cases above detailed fully sustains the dangerous character of this malady, its long period of incubation and insidious progress, so that it may be carried by in health, and may progress in its subjects so as animals still to render them dangerous or fatal to others before their diseased condition is suspected, and even after apparent recovery the animal may carry for months a portion of diseased lung charged with the fatal virus, of sufficient power to start new cases of the plague.*

The fearful losses to the country should this disease gain a permanent foothold, as it has in Great Britain, where the annual loss from death alone of cattle by this malady is estimated at $10,000,000, warrant the most extreme measures to secure its extirpation, and prevent its future importation. As the great cattle growing sections of the west and southwest are more interested than the few seaboard States where it has now gained a footing, national legislation is required to protect the whole country. State legislation may do much, and it is with honest pride that we refer to the work of this commission in Connecticut, but as it is a matter of national interest, it should be met by national authority and resources. We would suggest the necessity of more complete legislation in this State to make the labors of your commission more efficient and satisfactory.

BONE-AIL, JOINT-AIL.

Early in August our attention was called to lameness in cows in Farmington. Here again we called Dr. Cressy, and he made examinations there and elsewhere. We find it confined to no particular breed, or to any one section of the State. As cows alone are affected, we attribute it to over-lactation, accompanied with imperfect nutrition. Bones or superphosphates for our fields, pastures, and meadows are suggested as preventives. When the disease appears, the early drying of the milk and feeding on sound grain, oats, or barley would be good treatment. The milk should not be used for food, and when the disease has become confirmed there is little hope of recovery.

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* Mr. Mead has retained some of his convalescent cattle, and added others this winter, resulting in a new acute case.

CATARRHAL FEVER.

We have been called to numerous cases where herds of cattle have been suffering from some lung trouble, in some of its symptoms resembling pleuro-pneumonia. In every herd affected, all or nearly all the animals have suffered; there is moderate fever, coughing in paroxysms, failure of the milk, and general lack of thrift. We particularly examined the herd of Mr. Hawley in Danbury, the latter part of October, with Dr. Hopkins of New York, in the employ of the New York State Cattle Commission, and of Mr. David Porter of Waterbury, in November, with Dr. Cressy and Dr. Bland, a veterinarian of Waterbury. None have died from this disease, and all are now convalescent. Other cases came under our observation, indicating an epidemic, perhaps originating from the weather.

TUBERCULOSIS.

Though not allowed to be strictly contagious, your commission would caution every one against harboring an animal affected with this disease as worthless and dangerous. Hereditary taint, bad air, filth, insufficient food, exposure, and hardship are the most common causes. As the milk is unfit for food, even dangerous, as the animals seldom recover, and can give no suitable returns, either by their offspring, milk, work, or beef, for the food consumed, the animal suffering with this disease should be promptly destroyed.

GLANDERS.

In April our attention was called to the existence of glanders in several stables in the city of Hartford. Dr. Cressy was called to make an examination of the suspected animals, and Dr. Fuller, secretary of the City Board of Health, and Dr. Chamberlain of the State Board of Health, met us in conference. The symptoms of glanders were well marked, and we quarantined several infected animals, which were afterwards destroyed by their owners. Another horse in Bloomfield was likewise condemned, and also one in Middletown.

Some other cases to which we were called proved to be some less dangerous nasal or bronchial difficulties.

The public may be assured that the commission will spare no pains or expense within their power to banish from the State a disease so dangerous not only to property but to human life.

E. H. HYDE,
T. S. GOLD,
H. L. STEWART,
Com. on Diseases of Domestic Animals.

DISEASED MEAT, AND ITS CONSEQUENCES TO OUR HEALTH AND HAPPINESS.

BY NOAH CRESSY, M. D., V. S.*

The relations of man to the lower order of animals, zoologically considered, which of late has caused so much speculation among philosophers and naturalists, is equally interesting in a physiological and pathological point of view. The skeletal framework and internal organization of the higher mammalia are morphologically identical with that of man, and subserve the same purpose in the animal economy. The blood is similar in chemical composition, contains the same anatomical elements, and is subject to analogous changes in disease. Hence the liability of transmitting to the human system some virulent blood-poison or other morbid products through the medium of the animal food which we consume.

Consequently I believe that there is no subject of more importance to the public health or better calculated to enhance the cause of sanitary science than the practical study of diseased meat. And though many inquiries have been made in this direction and some valuable conclusions reached, yet in this broad field for scientific research the accomplished laborers are few. But the hour has come when the sanitarian and physician, in response to a public demand, must join hands with the veterinary profession to explore certain realms in the causation of disease and also more accurately survey those boundary lines in pathology which have served as a barrier to the progress of knowledge on this subject, and even now seem to separate the human maladies from those of our food-producing animals.

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* This lecture was omitted in its proper order.

In fact the very condition of some of our meat supplies already indicates the solution of certain vexed questions on the origin of disease that have been a stumbling block to the medical practitioner. The investigation of this subject, therefore, in all its varied relations to our health and happiness, is a work of vast importance, and one which the age now demands, in behalf of sanitary science. Hence it will require for the achievement of these results not only the united efforts of professional and scientific men but the influence of the public purse and the sanction of our State authorities. Then may we hope to see a thorough system of veterinary inspection established in this country, that shall have full control of the public markets, and examine all suspicious animals before they are allowed to be slaughtered.

NATURE OF DISEASED MEAT.

Few questions in dietetics have been more thoroughly discussed of late years, both by the rich and the poor, than the sanitary condition of animal food; and the difference of opinion on flavor and quality of meat is in a great measure due to habit and education. Our appetites are capricious, and as there is no accounting for taste; what suits one individual may fail to relish with another. But an unpalatable article of meat is not necessarily injurious. In fact, the flesh of animals suffering from a great variety of maladies may be eaten with impunity. Yet the flesh of some, without an apparent symptom of disease during life, may prove fatal when consumed by man. There are certain malignant maladies, also, quite prevalent among some of our domesticated animals, that do not produce an unpleasant flavor in the meat for the palate of the epicure, but which, in the advanced stages, often render the carcass exceedingly hazardous for the butcher to dress.

All meat, therefore, from whatever source or condition of an animal it may come, that would cause sickness, disease, or death in man if partaken as food, must be regarded in the light of sanitary science as diseased, and consequently unfit for human use in any form. Accordingly an article of meat possessing such qualities must come from an animal afflicted with some form of an infectious malady, the germs of which are contained in the flesh, and are liable to be transmitted.

Hence a disease in which a contagious virus is developed during its course, or a virulent principle generated in the blood, renders the meat from all animals thus affected exceedingly dangerous as an article of food. But meat is not materially affected by the entozoic maladies of animals, unless the parasite in some stage of its existence makes its abode in the flesh and has not been destroyed by cooking.

In accordance with this definition there are but few diseases that absolutely render these animal supplies perilous to human happiness. Prominent among these may be mentioned malignant anthrax, hydrophobia, tuberculosis, small-pox, and two parasitic affections caused by the trichina spiralis, and the measle tape worms. But the other maladies from which our slaughtered animals are liable to have suffered may greatly impoverish the nutritive quality of the meat, and thus render it unpleasant in taste and general appearance, yet if the flesh contains no animal poison or other morbid products no harm can possibly come from its use when served upon our table. And even a diseased article, when thoroughly cooked, may not prove injurious to one whose digestive powers are active.

It is not an easy matter, therefore, in all cases to decide whether meat is possessed of injurious qualities or not without a careful inquiry into the history of the article, or a microscopic inspection. Trichinous pork is an example of this kind; and of the many fatal cases on record, none of the victims ever suspected the meat until a peculiar form of sickness made its appearance, involving a number of individuals who were known to have partaken of the same. This is also true of black-leg veal many times, and of other fine looking specimens of meat that are affected with anthrax poison.

Many varieties of diseased meat, however, are so palpable that even by the dexterity of the butcher's art it is impossible to disguise them. The tuberculous deposits upon the pleural membrane lining the chest cavity, thus causing the lungs to adhere to the ribs, or along the internal walls of the abdomen, are sufficient evidence to condemn the carcass. Measly pork and beef are also easily detected by the unaided eye; but the parasitic contamination of such meat is often overlooked, and consequently there is a fine opportunity for a tape worm to become initiated in all who may partake of it.

The extent to which the different kinds of diseased meat are liable to be used will depend in a great measure upon the comparative frequency that these infectious maladies occur among the live stock in a given locality; and the more insidious the nature of the disease the greater is the liability of animals being slaughtered that are more or less affected. Hence a brief description of some of the more common forms of suspected meat, with a review of the pathological conditions of the disease in question, will best serve our present purpose, and possibly throw a gleam of sanitary light on this much neglected subject.

CONSUMPTIVE BEEF.

The meat from cattle affected with tuberculosis is not unfrequently seen in American markets, especially in our larger cities, and even in country towns. Yet, owing to the lack of public appreciation of any sanitary police measures to control such traffic, little or no complaint is made when we are served with consumptive beef. Five years ago, after repeated opportunities for observation on this subject, I called your attention to the prevalence of this malignant malady among our dairy stock, that I believed was publicly almost unknown. And I now affirm with renewed assurance in a pathological point of view, that its baneful consequences to our health and happiness from the use of meat and milk are not surpassed in the whole catalogue of contagious affections.

As this disease is comparatively new to the veterinary profession, its clinical history and pathology has not received that attention which the subject now demands. In fact, few are aware to-day of the extent to which this insidious malady prevails, but the rapid strides which it has made and the hold it has already gained on our stock, observes a veterinary author, renders it one of the most important questions affecting the well-being of the bovine species.*

The contagious nature of tuberculosis, as shown by recent experiments on animals, can no longer be doubted, and it is now conceded by comparative pathologists that the bovine form of this disease is identical with that of man. Consequently there is great liability of its transmission, either by inoculation or ingestion. In fact, it has repeatedly been produced in rabbits, Guinea-pigs, and calves by feeding them with tuberculous matter. And Prof. Gerlack of the Berlin Veterinary School claims,† as the result of his researches, that this disease in cattle is very infectious, that the presence of a specific virus is evident, and that even the flesh of such diseased animals under certain circumstances, and also the milk, possesses infective properties, though to a less degree than the cheesy matter from the lungs.

There is evidently a strong predisposition in neat stock to this disease, and they are more frequently affected than other domestic animals. The temperament and physical confirmation undoubtedly contribute much to its development; for animals of a phlegmatic type, with an attenuated form, long limbs, and narrow chests are usually the first victims of the malady. Breeders should therefore strive to avoid the possibility of transmitting such diseased qualities. It is more frequent in cows than in oxen, and especially those kept in dairies for a length of time. Hence lactation is believed to be a predisposing cause. The condition also in which animals are kept are no small factors. The cold, damp sheds, the dark, underground stables, and other ill-ventilated abodes, as well as the character of the food, all conspire to rekindle those constitutional taints into morbid activity.

That tuberculosis is rapidly on the increase no well-informed veterinarian can deny. It ranks among the few great scourges of the land; and though our losses, thus far, in live stock property have been largely due to other plagues which sweep their victims off in a manner to be seen by all, yet the ravages of this disease can only be realized, as Prof. Walley of Dick's Veterinary College* observes, when we take into account the vast deterioration, the slow but certain decimation of many of our best herds, the destruction of our animal supplies, and also the danger to human life which can no longer be considered chimerical. Still there are many who from want of knowledge on the subject may even despise the pathological significance of this fell destroyer and thus ignore its deadly meaning, but when we see thousands of these tubercular deposits in a single slaughtered animal, we are forced to conclude that the use of such meat can in no way promote our happiness. Thus we have in every form of tubercle an implacable and destructive foe, and, in fact, there is no other morbid product known that is so *protean* in the number of functional derangements to which it may give rise in the animal economy.

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* The Four Bovine Scourges, with an Appendix on the Inspection of Meat, etc., by Thomas Walley, M. R. C. V. S., Edinburgh, 1879.

† The Veterinarian, London, March No., 1875.

If we inquire further into the causes of the increased susceptibility to the infection, as seen more especially in our thorough-bred stock, we shall find that heredity and multiplied consanguinity play no menial part. Any physical weakness which the sire or dam may possess is liable to be transmitted to the immediate progeny, but if one generation escapes, the trouble may appear in the next, in accordance with the well-established principle of atavism. Diseased conditions are also inherited; and I believe that there is no predisposing cause which exercises such a potent influence in the production of tuberculosis as the pernicious system of in-and-in-breeding. Thus from parent to offspring, from one generation to another, we often see the fatal tendency transmitted in unbroken succession, and the more complicated the relationship becomes, the greater is the virulence of the resulting products. In spite, therefore, of the many palpable examples of this broken law, some breeders still pursue, year by year, the suicidal policy of clinging to *one strain*, regardless of the impending consequences. And Prof. James Law of

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* See The Four Bovine Scourges, page 143.

Cornell University, when speaking of consanguineous unions says, "That the esteemed qualities have been preserved, strengthened, and increased in this way there can be no doubt, but there can be just as little doubt that any inherited weakness or disease has been often transmitted and even intensified. I could mention particular families in our highest priced breeds in which tuberculosis has become a fixed character." And further on he observes that "excessive weakness and stupidity of the young is another common result of in-breeding."*

In 1865, Prof. Villemin of the Val-de-grace Hospital, Paris, having conceived that human consumption in certain cases might be due to a specific virus introduced into the system, resorted to a series of experiments on animals to test the question. He was the first to demonstrate the contagiousness of tuberculosis by inoculation. Rabbits and Guinea-pigs were selected, and the material employed was from the human lung. Inoculations were made in various parts of the body, but the results were uniform and of a serious character. Many of the creatures died, others, lingering in a depressed state, were killed when well marked tubercular deposits were found in all, especially in the lungs, and with more or less infiltrations in the other organs, thus showing that the disease had been transmitted.

These results which gave him so much renown as a pathologist led him to experiment with tubercular matter from other animals. Desirous, therefore, of testing the nature of the disease in cattle, he inoculated a rabbit with matter from a cow. The animal became emaciated, and in six weeks was destroyed. Its lungs were filled with hard, tubercular masses, and some of them had taken on a cheesy aspect in the center. The other organs of the body were affected in a similar manner as those in the previous experiments. Hence he concludes that bovine phthisis is identical with that of man.

Dr. Villemin has likewise demonstrated that the tuberculous matter produced artificially by inoculation possesses the same power of transmissibility as when the malady arises spontaneously,—thus proving conclusively that in tubercle resides a special elaborated virus which does not lose its identity by several removes, the same as small-pox.* This view of the subject is corroborated by the pathological researches of Dr. Lionel Beale of London, the celebrated microscopist, who declares that tubercle is a minute particle of living matter, and if inoculated under favorable circumstances it is almost sure to grow, multiply, and produce other morbid cells like that from which it was derived.† And furthermore, Villemin has always considered tuberculosis a *specific* malady, for he found that a very small wound and an inconsiderable quantity of matter used was a manifest proof that the intensity of the disease is independent of the *quantity* of the matter inoculated, and that the number and extent of the internal lesions have no relations to those at the seat of puncture.

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* Report of the Am. Public Health Association, New York, 1875, vol. 2, p. 250.

A disease, therefore, that can be transmitted from one animal to another by inoculation and thus an identical virus reproduced is, strictly speaking, *contagious*. But further and more convincing proof on this subject has been furnished by Prof. Chauveau of the Lyons Veterinary School, who for years has been experimentally studying the intimate pathology of the various contagia. The success of these researches has afforded some startling results pertaining to the use of diseased meat. The discovery also that certain rich virulent matter can infect as readily through the digestive organs as by any other channel has given him a world-wide reputation. And his well-designed experiments on cattle, which he instituted in 1868, have settled for ever among comparative pathologists the question of the virulency of tuberculosis.

He purchased four calves the 18th of September, from a locality where this disease was unknown, which upon rigid examination were found to be in fine, healthy condition. The next day he administered an ounce of tubercular matter from an old cow's lung, including the hard and soft varieties, prepared in the form of a drench and given in divided doses. The first one, a year old, began to lose condition in about a fortnight, the respirations were quickened, though the appetite remained unimpared. On the 5th of October he gave this calf another dose, but of different and more recent matter, and within a week the symptoms of tuberculosis were apparent. Emaciation proceeded rapidly, the coat became rough and staring, and the animal had occasional fits of coughing, especially after drinking.

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* See *Veterinarian*, for January, 1875.

† The Microscope in Medicine, fourth Ed., Lond., 1878, pp. 329–38.

The second calf, six months old, had on the fourth day a profuse and fetid diarrhœa, but of short duration, and the animal remained apparently healthy for three weeks. But the characteristic symptoms as in the other case soon appeared, with enlargement of the glands about the throat. The third one of the same age, having shown no signs of disease, was drenched again October 9th with another kind of matter, but this calf longest resisted the action of the virus, and not until the 25th was there any appreciable derangement of health; but from that time, however, the phenomena of tubercular infection ensued with amazing rapidity, and in a week the calf could scarcely be recognized.

At the close of the experiments, November 10th, the miserable aspect of the three infected creatures when contrasted with the thriving condition of the fourth left no doubt in the mind of even the casual observer as to the changes that had taken place. The post mortem examinations revealed a perfect generalized form of tuberculosis, with the local lesion of the bowels, *tabes mesenterica*, shown in a marked degree, some of the glands being as large as a man's fist. The morbid deposits in the chest cavity also were none the less remarkable. The lungs were studded with crude tubercles, some forty in number, varying in size from a pea to a filbert. The bronchial glands were also involved, but the liver, spleen, and kidneys were not affected.

Thus in the space of fifty-two days we have three typical examples, nearly uniform in appearance, of the artificial production of this malignant malady through the digestive organs. In presence of these facts, therefore, I trust that all inquirers after the truth of this matter will be forced to conclude with our illustrious pathologist that the virulence and contagious properties of tuberculosis are now demonstrated beyond a doubt. And the fact that bovine animals have contracted this disease through the agency of the feed gives us an additional source of danger, for creatures confined in the same stable or pasture, and drinking from the same ponds or troughs, are constantly liable to swallow some of this virus in the mucous discharges from the nostrils of their affected comrades. In fact it is never safe to put another animal in the same stall where one has sickened and died of this complaint without thoroughly renovating the apartment. Nor would I allow an affected creature to mingle with the healthy stock about the yard.

The observations of Dr. Grad,* veterinary surgeon at Wasselonne, Alsace, on the spread of this disease by contaminated stalls, are very conclusive. On different occasions owners had informed him that they had lost several animals from consumption *in the same stall.* At first he did not attach much importance to the matter, but one day, when visiting the stables of an extensive farmer in Leinheim, he was informed that annually for the last five years one of the cattle had died of tuberculosis in a certain stall. The last one he had the opportunity of examining, which had been there but ten months, but had all the symptoms of the malady, greatly emaciated, and troubled with a cough. Dr. Grad's attention was strongly aroused at such a state of things, and to test the matter scientifically he was allowed to select an animal for an experiment. Accordingly he chose from another stable a three-year-old heifer, in calf, that was to all appearances perfectly healthy. She was bred on the farm, had never been unwell, never coughed, and none of her progenitors had ever been affected with phthisis. The cow remained quite well until after calving, when a slight cough appeared; but it increased in frequency, emaciation gradually set in, with all of the symptoms of tuberculosis, and in twelve months the creature was a mere shadow of her former self. The evidence therefore in support of this mode of infection Grad could no longer resist, as this was the sixth case that had occurred in this stall. Hence he very naturally inferred that the disease was probably transmitted by the ingestion of tuberculous matter expectorated by the cattle which had previously occupied the place.

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* See Fleming's able memoir on the history of these investigations in the 48th and 49th Vols. of *The Veterinarian.*

The extension of the malady by cohabitation is therefore always liable to occur when animals are so arranged in the stable that the sick and healthy ones can get their heads together, or feed from the same manger. The hay may thus become contaminated, and the infection takes place through the digestive organs. The expired air also is not unfrequently so laden with virulent matter, especially in the advanced stages, that it is not safe for another animal to inhale it. This mode of transmission, which was first suggested by Dr. Morgagni,* more than a hundred years ago, and has found many advocates among physicians and veterinarians, has now been confirmed by the experiments of Dr. Tappeiner of Meran, in causing animals to inhale the fine particles of tubercular matter from the air of a room in which the virus had been evaporated by a steam atomizer. Out of eleven puppies experimented on, ten showed well-marked miliary tubercle in both lungs on being killed within twenty-five to forty days—thus proving that this disease is contagious by the breath.

The relation of bovine tuberculosis to public hygiene was probably first suggested by Prof. Chauveau, who twelve years ago had already indicated the real source of danger from the use of consumptive beef and milk. But no one has done more to promulgate these investigations, or has contributed more to the advancement of veterinary education in this direction, than George Fleming, F. R. C. V. S., inspecting veterinary surgeon to the British army, and the learned editor of the London *Veterinary Journal*, who, by his encyclopedic writings, has now become an acknowledged authority on the subject.† And in a recent editorial,‡ he says, "That the tuberculosis of cattle is a transmissible disease, and can be conveyed not only to animals of the same but also to those of other species in various ways, is now an established fact, upon the recognition of which we have for many years insisted; and since we first called attention to it, some of the best pathologists in Europe have furnished additional testimony as to the readiness with which this transmission takes place, not only by inoculation or ingestion, but also, it would appear, by cohabitation of diseased with healthy animals.

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* Nature and Cause of Diseases. Lond., 1769.

† See his Manual of Veterinary Sanitary Science and Police, in two vols., 8vo, illustrated. Lond., 1875.

‡ *Veterinary Journal*, Dec. 1879.

Early in 1879, Prof. Colin of the Alfort Veterinary School contributed a series of observations with regard to the communicability of the disorder; several German and Italian authorities have also published their clinical experience in this direction; and lastly we have the celebrated Prof. Orth of Gottingen, furnishing the results of his researches and experiments. All these are only confirmatory of what we have already stated, but this confirmation is not without its value. Dr. Orth's experiments once more demonstrate that the transmission of bovine tuberculosis is possible between different species of animals, and he also points out the complete analogy or rather perhaps identity, which exists between it and the disease in man.

In his experiments, fifteen animals were fed with tuberculous matter from a diseased cow, and nine of those were infected, of which four died. The remaining five becoming extremely emaciated, were killed. On examination nearly all the organs of the body were found involved in tuberculosis. In all the lungs were affected, but the serous and mucous membranes, the lymphatic glands, the liver, spleen, kidneys, and omentum, were infected in different degrees. And consequently the transmissibility of this affection to animals being proved, he insists that its transmission to man is possible.

The meat of animals affected with this disease should not be used, for any organ or texture in which tubercle has been deposited is surely a dangerous article of food. Much will depend, however, upon the severity of the case and extent of the morbid changes that have taken place. Thus, from what is known in relation to the pathology of this virulent malady, we should at once interdict the sale of consumptive beef and milk, especially in the advanced stages of the disease, when the glandular tissues have become involved. As the commencement of phthisis is often so insidious in the human subject, and so very difficult at times to arrive at the exciting causes, it is to be feared, at least, that one of the sources of its invasion, according to recent experiments, is to be referred to the utilization of the carcass, but more particularly the milk of such diseased cattle, as food.

There is every reason therefore, says Fleming, to prohibit the use of milk from cows affected with tuberculosis, and especially for infants, who mainly rely upon this fluid for their sustenance, and whose powers of absorption are very active. Even if it did not possess infective properties, its deficiency in nitrogenous elements, fat and sugar, and the increased proportion of earthy salts, would alone render it an objectionable article of diet. In fact, it has long been known that it was liable to produce diarrhea and debility in infants; but though many children fed on such milk have died from tuberculosis or a localized type of it in the bowels known as *Tabes mesenterica*, the part probably played by this liquid in its production has rarely been suspected.*

The recent investigations of Prof. Otto Bollinger of the University of Munich, on the artificial production of tuberculosis as induced by the consumption of diseased milk, has thrown additional light on the subject. He claims that the milk of such animals has a pre-eminently contagious influence, and reproduces the disease in other animals experimented on from that point of view. He believes also that such milk, even when boiled, still retains its injurious properties. Further, he maintains that beyond doubt the tuberculosis of the human subject, though not completely identical with that of the cow, is yet strictly analogous to it, and that consequently the wide prevalence of tuberculosis in the native herds, at least 5 per cent. of which are affected, is a standing danger to health of the community. Seeing the enormous mortality from consumption, more especially in towns, Prof.

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* Paraphrased from his Sanitary Police, Vol. 2, page 396.

Bollinger believes it to be of the utmost importance to urge upon all classes, and particularly upon farmers, the absolute necessity of taking every possible means of stamping out the disease among cattle. Meanwhile some measure of safety may be secured by the rigid exclusion of all diseased stock from town dairies, a measure which forms a prominent feature in the programme of the recently established Associated Dairy at Munich, where all the cows are constantly kept under skilled veterinary surveillance, and any that may exhibit the least symptom of tuberculosis are at once weeded out.*

Thus we have abundant proof of the noxious condition of consumptive milk. Comparative pathologists are now agreed on this point; but whether the meat of such diseased animals in the early stages possesses the same infectious properties awaits further investigation. New experiments will be required, and should be instituted at once by State authority, to solve this momentous question pertaining to our health and happiness.

TRICHINOUS PORK.

There is probably no condition of diseased meat more inoffensive in general appearance, and therefore more liable to be overlooked in the culinary process, than the one caused by the presence of minute worms in the flesh of swine. Such meat is exceedingly dangerous as an article of food, and may give rise to one of the most obscure and intractable maladies that the physician has to contend with in human practice. These famous microscopic entozoa that so frequently contaminate our pork, and are known among naturalists as the *Trichina spiralis*, present in their evolution three well-marked stages of existence for us to study, which really anticipate the larva, pupa, and imago phases of development in the winged insects. The natural history of this flesh-worm, therefore, becomes not a little interesting and worthy of special notice in this connection when we endeavor to explain the precise manner of its infection, the phenomena of certain symptoms, and the ultimate cause of death in the human victim.

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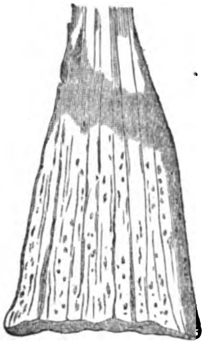
* *Veterinary Journal*, Feb. 1880.

This parasite was first described and named by Prof. Owen[*] of London, in 1835, and though frequently seen by scientific observers, it was only regarded as a microscopic curiosity for more than a quarter of a century. His attention had been indirectly called to the subject some two years previously by John Hilton, demonstrator of anatomy at Guy's Hospital Medical College, who had observed a peculiar appearance of human muscle, and thought that it depended upon the formation of very small *cysticerci*. He made a communication to the Medico-chirurgical Society which was deemed worthy of publication, and this is probably the first account we have of the abode of the worm in question.[*]

Figure 1.



A portion of human muscle showing the cysts of the Trichinæ spiralis, natural size.

Mr. Wormald, the demonstrator at the St. Bartholomew school, had frequently observed the same abnormal and speckled condition of certain muscles. The gritty sensation he had perceived, and the blunting of the edge of his scalpel in dissecting, caused him one day to mention the fact to Prof. Owen. This led to some inquiries concerning the nature of these little calcified bodies in the flesh, and the distinguished anatomist at once requested a specimen for microscopic examination, as seen at Fig. 1, from the next subject he should find thus infected. It was not long before his wish was gratified, but ere he had time to investigate the matter, one of the students, now better known as Sir James Paget, dissected some of the calcareous cysts, and with the aid of a microscope, which he borrowed from Dr. Robert Brown, the well-known botanist, he actually saw the living entozoon first.[†]

Dr. Vogal in his description of the cyst gave it the appellation of "cocoon," believing that it was formed by the ingenuity of the parasite. Owen found each capsule to contain from one to three small hair-like worms,[‡] invariably coiled up, hence he gave it the very appropriate zoological name the parasite now bears. As this examination was made with a low magnifying power, he did not perceive that the little *helminth* had any internal organization; he therefore arranged it among the lowest of the entozoa in his new-made class *Protelmintha.* But Dr. Arthur Farre* by his careful dissections soon distinguished an alimentary canal, which at once elevated the parasite in the classification of naturalists to the order of nematoid worms. Yet he was unable to decide which was the anterior extremity, and for nearly fifteen years there was no advance of anatomical knowledge on the subject. It therefore remained for Prof. H. Luschka of the Tubingen University, in 1850, to point out more accurately the internal structure. He carefully traced the digestive canal, discovered the sexual organs of the female, and conclusively proved that the mouth was situated in the pointed end of the worm, and not in the blunt extremity as was generally believed. He described the cyst in its advanced stages, and demonstrated for the first time a complicated system of blood vessels, and an external membrane of connective tissue by which it is surrounded. In his observations on the vitality of the trichinæ, he found that they survived putrefaction and freezing of the muscles. Dr. Herbst, a German helminthologist, followed in this line of investigation, and his experiments on dogs actually solved the question concerning the propagation of trichinæ. He was the first to rear encapsuled flesh-worms in the muscular tissue, and claimed that in this state only they were transferable from one animal to another.

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[*] Transactions of Zoological Society, Vol. I, page 315.

[†] See London Medical Gazette, Vol. XI, page 605.

[‡] Cyclopedia Anat. and Phys., Vol. II, page 126.

Dr. Kuchenmeister, having previously shown the transformation of measles or hydatid tæniæ into tape-worms, was led to the supposition that the trichina might be a juvenile form of a known nematode; and after a series of observations, he declared that this flesh-worm was the larva of the *Trichocephalus dispar.*†

A new impulse was given to trichinal investigation in 1859, by Prof. Virchow's experiments. He fed a dog upon trichinous meat, and in four days found a large number of these nematodes fully developed and sexually mature in the intestines, but he failed to observe the migration of the new-born worms which Herbst had previously demonstrated. This was owing partially to his having killed the dog too early, and also from the fact that he selected an old animal for the experiment, through whose firm tissues the young trichinæ scarcely ever penetrate.

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* London Gazette, Dec., 1835.

† Animal and Vegetable Parasites, Sydenham Ed., Vol. I, page 321.

Dr. Zenker of the Dresden Medical School supplemented these observations, and threw much light upon the subject in a medical point of view. He found, upon microscopic examinations, free and living trichinæ in the muscles of a servant girl who died in the hospital, at the age of twenty, of what was supposed to be a typhoid fever. She was taken ill January 12, 1860, and fell a victim to this strange malady within a month. Her symptoms were severe, and in some respect resembled rheumatism, with painful swellings of the limbs. The history of the case, therefore, was of more than usual interest to the profession, and excited not a little clinical inquiry, but no one mistrusted the cause of the trouble. It was soon ascertained, however, after Zenker's post-mortem disclosure, that she had assisted in the making of sausage on the 21st of December previously, and that she had partaken of some of the raw meat only a few days before her illness. This led to his well-known investigation on the nature and pathology of trichinosis, which has been so extensively published to the world, and will ever crown his life with honor. The discovery of this violent parasitic disease in man aroused at once the zeal of professional experts and veterinarians, and was the dawn of a new era in sanitary science.

Prof. R. Leuchart,* of Giessen, followed up the researches on the embryology of the parasite; he made a series of experiments on trichinal infection that were very comprehensive, and did much to advance the science of helminthology. He corrected his own previously expressed opinion on the validity of Kuchenmeister's observation on the transformation of the flesh-worm into trichocephalus, and thus confirmed Virchow. He also showed that the young trichinæ in the intestines became the encysted worm in the muscles, and he believed that they reached there by migration through the tissues, while others claim that the distribution of the trichinæ over the body in so short a time can only be effected through the circulation of the blood.

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* For a summary of his views see Burk's translation in Quar. Jour. of Microscopical Science, Vol. VIII, page 168.

Dr. Thudichum,* who has made extensive researches on the parasitic diseases of food animals, says, concerning this worm, that the red voluntary muscles are the "promised land" of the trichinæ. There they migrate, grow, and enshrine themselves. Although the young trichinæ, on the seventh day and later after infection, are found in almost all the organs of the body, yet they do not grow or become encapsuled in any other tissue. The trichinæ arrive in the muscular tissue with the blood. The diameter of the smallest capillaries in the muscles is much less than the diameter of the young trichinæ, so they are certain to be arrested. They then penetrate the simple or double coats of the muscles, and are at once in the interstitial spaces between the muscular fibers. Many trichinæ unquestionably never enter the sarcolemma, and become encysted, but when they do the fibers become permanently destroyed. At the end of the third week after immigration, the inflammatory irritation of the muscular fiber has reached its highest point, the trichina is nearly full grown, and becomes fixed to the spot where it is to be encapsuled. Several of these worms may wander in the same track, and ultimately be enclosed in one lump of exuded matter.

It is in the encysted state, as seen at Figure 2, that the trichina is transported from one flesh-eating animal to another. Pigs are not born with these entozoa, but get them in some kind of food, probably from the flesh of rats and mice, and when once swallowed by the hog or other animal, the gastric juice, in the process of digestion, soon dissolves this albuminono-cretaceous cyst, when the parasite will be liberated

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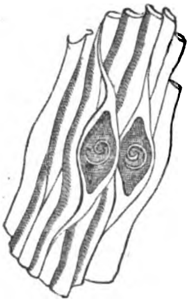
* See his able paper on the subject in the 7th Public Health Report of the Privy Council, London, 1865.

Figure 2.



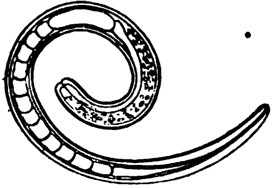
A portion of ham, showing two cysts of the Trichinæ spiralis enclosed, slightly magnified.

from its prison life, and in a few days becomes a full-grown worm.

The sexually mature female, according to Prof. Cobbold,* is one-eighth of an inch in length, while the male is only about two-thirds that size. The female is ovo-viviparous, and thus brings forth its young alive within the stomach and intestines. The young trichinæ begin at once to migrate from the bowels and perambulate the entire system of voluntary muscles; at last they become encased, and there remain for ever at rest, until they perchance shall have been eaten by some other animal, when they in turn will be set free, and thus complete their final destiny.

This parasite, which undoubtedly infects a large number of animals, has frequently been found in the rat, mouse, cat, hedgehog, fox, mole, and hog, and is liable to be transmitted from one carnivorous animal to another through the meat. The Commission of the Royal College of Physicians of Vienna report that the main source of the infection in the hog is from the rat, and nearly one-half of all these vermin examined in Moravia were found infected with the encysted trichinæ; and it is not improbable, as Fleming observes, that the rats were primarily infected and have thus transmitted these parasites from one generation to another by virtue of their carnivorous habit, at times, to devour each other.†

Figure 3.



Trichina magnified one hundred times.

Although the swine of every land may occasionally be infected with this noxious parasite, still the frequency of its transmission will depend in a great measure upon the habits of the people. In those countries where the practice of eating raw pork and sausages so extensively prevails, of course the parasites contained in the flesh will be transported to the human stomach unmolested, but no fears need be anticipated from even the free use of pork if it has been subjected to a sufficient degree of heat in the process of cooking to destroy every germ of animal life; then it would be as harmless from this cause as fish, beef, or venison.

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* See his Entozoa—An introduction to the study of Helminthology, with Supplement, London, 1869.

† Veterinary Sanitary Science.

The ravages of this loathsome malady from the use of diseased pork are not confined to any country, and I believe it prevails more extensively than is generally supposed. Dr. George Sutton of Aurora, Indiana, who has been examining pork killed in the State, says he has found from three to sixteen per cent. of the hogs affected with this disease—differing in various localities—and that, taking the rate at four per cent., we have put upon the market from the Western States 221,484 diseased hogs, or about 44,296,800 pounds of infected meat, every ounce of which might produce disease.* And the Committee of the Chicago Academy of Science has shown that the percentage of swine infected by the trichina in the Western States is greater than in Germany. Still, the disease is of rare occurrence on this side of the Atlantic compared to the old country, and we can ascribe no cause for the greater prevalence of this disease in Germany, except it be the habit of eating their ham or sausage in the raw or uncooked state.

The symptoms of trichinous infections in man will depend largely upon the quantity of diseased meat that has been eaten, and also upon the stage of the malady. At first it is marked by local irritation within the intestinal track, before the worms begin to migrate. This gives rise to nausea, loss of appetite, inflammation of the mucous surface of the bowels, and diarrhœa. Peritonitis may sometimes occur from the perforation of the intestinal walls.

The second stage is characterized by general symptoms, muscular pains, rheumatism, etc., occasioned by the migration of the worms in the various parts of the body. There is great soreness, œdema, and stiffness of the muscles. Lassitude and profuse sweating not unusually occur in severe cases, and in this respect it resembles typhoid fever, for which it has many times been mistaken. This stage commences in about ten days from the first illness, and lasts four or five weeks.

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* A report on Trichinosis, from the Transactions of the Ind. State Medical Society, 1875.

In the third phase of the malady the trichinæ have become encysted, the fever, soreness, and inflammation begin to abate, and the patient is in a fair way to recover. In many cases there is a complete restoration to health again, but often it leaves the system in a very prostrate condition, according to the amount of muscular lesion that has taken place.

Thus our only safety from the use of pork, which is always more or less liable to contain trichinæ in any portion of the country, is thorough *cooking*. Salting and smoking, unless long continued, has but little effect upon the vitality of these parasites. Raw ham or sausage should never be allowed upon a sanitary bill of fare; and even boiled ham, when large and fashionably prepared, as seen in many of our eating saloons to-day, not unfrequently contains these living worms. Hence our lives may be prolonged and our health improved by more attention being given to the domestic duties of the household. Then will all meats be served upon our table in a manner both to nourish and promote our happiness.

MEASLY PORK AND BEEF.

This condition of diseased meat is caused by the presence of a larval form of a tape-worm known as a *scolex* or a *hydatid* in the flesh, thus giving it the spotted appearance of the measles, and consequently this term has been applied to the parasite. There are several points of resemblance between the life-history of the tape-worm and the trichina. The measles are the young entozoa in the encysted state and likewise are received into the stomach with the meat, when they become liberated in the process of digestion and grow into the mature parasite. But tape-worms do not multiply like trichina in the human body. Each one comes from a hydatid measle that has been eaten.

The posterior segments of the tape-worm ripen and fall off, and are known as progottides. Each one is sexually complete, a hermaphrodite, and contains a multitude of mature ova; and when eaten by other animals the eggs, set free in the stomach, readily hatch, and the embryo worms with their six hooklets or spines arranged about the head soon perforate the intestinal walls, enter the blood-vessels, and are transported by the circulation to all parts of the system. Being therefore a foreign body in the flesh, inflammation ensues, and they are soon enclosed by an exudation thrown out for protection, and thus a cyst is formed where they develop into a measle, or the *cysticurcus celulosæ* of early authors.

The larval cestode which infests the measly pork is the sexually undeveloped progeny of the armed tape-worm known as the *Taenia solium* of Linnæus. And while the pork measles have been found in the flesh of other animals, the adult parasite seems to claim no other host than the human intestine. The pork tape-worm is probably the best known and by far the most prevalent. In fact, this intestinal parasite is only too frequently the pork-eater's guest. It is therefore obvious that the measly condition of the flesh of swine is the real source of danger.

Hence the necessity for more precaution on our part in rearing these animals for home use or for the general market. Thus a person harboring a single tape-worm may be the means of contaminating many hogs, for each mature segment cast off contains thousands of eggs ready to hatch when taken into the stomach of other animals. Consequently swine should never be allowed access to privy dwellings nor to compost heaps containing night-soil. Better sanitary regulations are therefore demanded even in the homes of the affluent.

The beef measle when eaten by man develops into the *Taenia mediocanellata*, which Kuchenmeister first described and named.* This tape-worm was looked upon for a long time simply as an unarmed variety, but it is now known to be a distinct species. It is larger than the other and the joints are wider. This parasite occurs among beef-eating people, and is quite common in America and European countries. In fact, it prevails most extensively among the Jews and Mahommedan nations, where pork is not used, thus showing conclusively that the broad, unarmed tape-worm comes from the use of measly beef and veal.*

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* Animal Parasites, Vol. I, page 133.

The same sanitary measures will be required to protect the cattle against this larval infection. Their voracious habits sometimes will cause them to eat strange substances. Cattle should therefore not be permitted to frequent those places where human ordure has been left, or to drink from dead ponds that receive the wash from dwellings, especially when it is known that people in the neighborhood are infested with the beef tape-worm.

Though our staple articles of meat may be affected with these larval parasites, yet thorough cooking renders all such flesh perfectly harmless. Raw pork, veal, and beef are dangerous articles of food unless a microscopic examination has been made to determine the possibility of any parasitic infection. And Prof. T. Spencer Cobbold of the Royal Veterinary College, who by his original researches has contributed so largely to our professional literature on this subject, has announced the discovery of a mutton measle, differing in some respects from those other two; but whether the resulting tapeworm will make its abode in man, and thus render the favorite flesh of sheep a diseased article also for human use, has not been determined.

The mature ova of the *Tænia solium*, when taken into the human body with food or drink, develop into the measle quite as readily as in the hog, and thus our own flesh is liable to become the bearer of these larval parasites, a single one of which may prove fatal. Hence, we should strive to guard against all such possible contingencies.*

BRAXY MUTTON AND BLACKLEG VEAL.

In this type of diseased meat we have a virulent blood poison to deal with which infects the entire carcass; and accordingly all animals dying from an anthrax fever in any form should be condemned. Yet we find that the flesh of braxied sheep is a favorite article with many, and some even prefer it to the best dressed mutton in the market, claiming that it is more wholesome and easier of digestion. Such a taste of course must be an acquired one, like that of the epicures who seem to relish their game the best when in a state of decomposition. And some forms of braxy mutton are in a similar condition, being soft and putrid many times as soon as the animal is dead.* Such practice is much to be reprobated says a practical shepherd,† although it is almost universal among those connected with the stock in every district where the disease prevails, and in some places large quantities of hams are salted and dried; and from the amount consumed in certain localities there is no doubt but that it is the cause of many blood poisons among the people.

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* For further account of these measles see Prof. Verrill's able paper on Internal Parasites, in the Secretary's Report, 1869.

† See supplement to his large work on the Entozoa, 1869, and also his new Manual on the Parasites of Man and Animals, London, 1879.

Instances are not wanting where blackleg veal and other anthrax varieties of flesh have been eaten with impunity. There is evidently a great difference in the intensity of the malady. Sometimes the poison may not be fully elaborated, and consequently the virulency of the meat will be less energetic. Thorough cooking may do much to destroy these infectious properties, yet the extensive alterations that have taken place in the tissues and the rapidity with which putrefaction sets in are sufficient reasons, on sanitary grounds, to absolutely prohibit the use of all such diseased meat.

The nature, history, and symptoms of two very malignant anthrax maladies in cattle—splenic apoplexy and charbon—will be found treated at some length in relation to the diseased meat question in my third report, as State Veterinary Surgeon, on the Diseases of Domestic Animals within your State.‡

THE LUNG PLAGUE.

The question of the wholesomeness of meat from animals affected with pleuro-pneumonia is one of much moment to us to-day, and in view of the increasing prevalence of the malady in this country, it is worthy of our consideration and of our expressed opinions for the public good.

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* See Robertson's Prize Essay on Braxy in Transactions of the Highland and Agricultural Society of Scotland, Vol. 19.

† Cowan's Essay on Braxy, in the 18th Vol. of the above transactions.

‡ In the Secretary's Agricultural Report of 1873. See also Fleming's Veterinary Sanitary Science.

Since the first introduction of the lung plague in 1843, the herds of the New England and Middle States have not been free from its local ravages. During its history of thirty-seven years upon our virgin soil, the germs of this contagious malady have become so effectually disseminated along the Atlantic coast that fresh and unexpected outbreaks are now of frequent occurrence, especially in the vicinity of New York, where the disease first made its appearance.

The western movement of our thorough-bred stock of late years has opened new channels for the development of the disease; and unless immediate action is taken by Congress to intercept the impending scourge, these potent germs will ere long be found lurking among the vast herds upon the plains, if not already wafted there by the trend of civilization.

The cattle of your own State for some time past have been more or less affected by this disease, and thrice have we been called upon as a Commission in the last ten years to stay its progress. And still there is more work to be done, which your next Legislature in its wisdom and economy cannot ignore. And should pleuro-pneumonia, the dreaded plague of our land, ever become through political neglect a general epizootic, and thus sweep across the continent decimating our herds upon the hilltops and plains, we are not without a bright sanitary consolation in such an event to cheer the poor and broken-hearted, for the meat from thousands upon thousands of our fine animals that must of necessity fall victims in its march, if slaughtered at an early stage of the malady, could be utilized in a great measure to feed the hungry and needy without a fear of dangerous consequences to the health of our panic-stricken millions.

Thus our great dread of the extension of the lung plague is not on account of any infectious condition of the meat, for millions of those affected animals, according to Fleming, have been consumed as human food in various parts of the world, and no evil results have been known to follow. In Great Britain and France there has been for years a regular trade with the butchers in cattle affected with the contagious form of this disease, and yet the sanitary condition of the people remains unimpaired. But it is the immense loss to our live stock property that would be entailed by such a calamity.

CONCLUSION.

Of the other maladies which are liable to effect our meat supply, the foot and mouth disease is one that is much to be dreaded. And though the flesh of such affected animals is believed to be harmless, yet the milk, under certain conditions, is a dangerous article of food. But observers are not agreed in relation to the matter. The same is true in regard to hog cholera and several other forms of disease, the pathology of which is not sufficiently well understood to enable us, at the present time, to solve the various sanitary questions here involved.

Hence the necessity for a competent veterinary inspector in every State, whose professional duties to the public have already been outlined, in the consideration of our theme. And as we have seen that our health and happiness is frequently involved in the very meat we eat, such an officer, in watching the development and progress of these infectious maladies among our food-producing animals would thus serve as the true guardian of human welfare.

Prof. **Brewer.** What is hog cholera?

Prof. **Cressy.** "Hog cholera" is so named from the fact that the animal has discharges from the bowels, like cholera. It is occasioned by the filthy condition in which many of the animals are kept. Some medical men have thought that it was typhoidal in its character, and therefore it has been called a typhoid disease. That it is not identical with human typhoid has now been settled beyond question by Prof. McEachran of Montreal; but that it is typhoidal in its character, there is no doubt. The place affected is the bowel, and it looks like *enteritis*, and Bollinger, a German investigator, calls it *pneumo-enteritis*, because the lung is largely involved; not quite like the pleuro-pneumonia type, but the lung and bowel are largely involved, with a sort of inflammation, and therefore it is called *pneumo-enteritis*. I think that is the right pathological name for it. In the town of Holyoke, about a year ago, this very type of disease broke out in a herd of 75 hogs, that came from the West, and over half of them died. One man said to the owner, "Slaughter the rest of them at once, and send them to Springfield, or peddle them out here among the French." The man said, "I won't do it; I will lose the whole." "Why," said the other, "I know that hundreds of hogs with just that disease have been slaughtered. If I had been in your place, I should not have called a doctor over here; I wouldn't have let the Springfield *Republican* know there was any such disease here." That hundreds of hogs have been slaughtered in that condition, and that a large amount of pork has been shipped East of that character, is without doubt, and it has not proved fatal; but I fancy it does affect the flavor. I should not want to eat it. My impression is that it has lost a large amount of its flavor, but is not directly dangerous if the animal is killed at an early stage of the disease.

Prof. BREWER. I believe, in England, where there is an inspection of all meats, in some towns the meat of animals affected with this disease is condemned, and in others not. There are no specific cases where disease has resulted from it. Those who condemn it do it on general principles, and say it is suspicious, any way.

Prof. CRESSY. That is right. That is the ground we should take. But if called upon to say whether it will produce any injurious effect, I should have to answer in the negative. I don't know anything against it.

Mr. GOLD. How about measly pork ?

Prof. CRESSY. That is a parasitic disease; it is not the measles of the human subject. Measly pork is so called on account of containing a 'parasite which is known as the hog tape-worm. If you look under the tongue of a hog that has this parasite, you can see the little pimples that by and by will develop into tape-worms. That meat, if not well cooked, is unhealthy. The source of a majority of the tape-worms in the human subject is pork, although I have no doubt that in the case of children in filthy families where dogs and cats and pigs are running into the house, the tape-worms are derived from other sources.

Prof. BREWER. I had supposed that beef tape-worms were very rare, but those that have come to our notice in New

Haven have been more of them beef tape-worms than I had supposed to exist, although I think the majority are from pork.

Prof. **Cressy.** Yes, sir. I have been trying for a long time to get a beef tape-worm for my cabinet. You can send me one. I have plenty of the others.

Mr. **Perkins.** Do you know of a disease that our farmers around here are troubled with sometimes that we call "horn-ail," or "horn-distemper," and whether the hollow or rotten tail, that a cow sometimes has, has any connection with the disease of the head? After a while, the cow runs at the nose, and sometimes farmers bore the horn, and matter runs out. It is the practice among farmers to cut off the tail when it becomes soft.

Prof. **Cressy.** A little blood letting is a preventive of that disease.

Prof. **Brewer.** One word about the matter of cooking meats. I think the reason why we do not have more of this parasitic disease is because the meat we eat is generally well cooked. A friend of mine who was interested in this matter went to a butcher and told him he wanted a large piece of measly pork for examination. One day the butcher met the worthy doctor, and said he, "How did that suit you?" "What?" "Why, that piece of measly pork I sent around; I sent you ten pounds, and I have not heard anything of it." The doctor found that the ten pounds of pork had been cooked for dinner, and all the members of the family had eaten it. It was thoroughly roasted, and no harm came from it.

I think what was said about trichina has had the effect to make families cook their pork more completely, and that is the reason why there is not so much disease as there might be. But that there are cases of tape-worms still coming up, there is no question. The last specimen of trichina I have had came from persons who died. We made careful inquiry, and found that the disease was treated as a mixture of rheumatism and typhoid fever. There was no typhoid fever whatever. In that case the person had been killed by trichina, undoubtedly. I imagine there is considerable trichinous disease which is attributed to rheumatism or something of that kind.

Mr. **Perkins.** One reason why I asked the question about horn ail was because a great many of our farmers are troubled in this way. Not more than a month ago, one of my neighbors said his ox had got the horn distemper. In the August number of the *American Agriculturist* there was an article headed " Cutting Cows' Tails," in which it was stated that there was no such disease as tail-ail. I have heard several of my neighbors, who were well posted on this subject, say, " The man who wrote that is a fool, and didn't know what he was talking about." A good many of our farmers believe that the head and tail are connected together in this disease. I will read the article in the *Agriculturist.*

" CUTTING COWS' TAILS. 'A. E. H.,' Harmony, Kan. We mean what we say, when we state that it is unnecessary ever to cut off a cow's tail. There is no such disease as tail-ail, nor do we, or any intelligent veterinarians, know of any reason why the tail should ever be cut. 'B. V. B.' Monson, Mass., who thinks very highly of the *American Agriculturist,* asks what to do instead of cutting the tail, to prevent the hair from curling? Well, if one doesn't like the curl, he may cut it off; but we do not see why a cow should not wear one curl, especially as it does no harm."

Now, I want to ask the Professor if clipping the tail has any affect upon the disease that is called " horn distemper ? "

Prof. CRESSY. I don't want to take time to discuss a subject which I supposed had been well worn out and was perfectly understood throughout the country. But I will say that I fully agree with the statement made by the editor of the *Agriculturist.* In the first place, there is no connection between the tail and the brain or head, only by the nerves and a series of bones. You must understand that the canal that is in the bones of the back is not filled with marrow, as in the leg, but with brain matter. It is a continuation of the brain right back, known as the spinal cord, that gives off all the nerves that supply the body, and that is the function of the brain itself. If you should cut that cord off, perfect paralysis of everything behind it would ensue. Now, if you have a disease commencing in the end of the tail and working up through that brain matter towards the head, what would the condition of the animal be when it got up about the middle of the back? Think of it a moment! It is not marrow that is in the back bone, it is brain, and you have that disease going up through that brain! It is pure nonsense for any man to say that the tail has any connection with the head, in the way that has been suggested.

I will say, further, that there is no such disease as horn-ail, and cannot be, as the formation of the horn clearly proves. [The Professor here exhibited a horn, and gave an account of examinations he had made of a great many horns, which resulted in proving the correctness of his statement.]

Mr. Bill. I would like to hear something upon the subject of wens. We are troubled more or less with wens on our animals, from the size of a hen's egg up to a water-pail.

Prof. Cressy. The next time you find one, Mr. Bill, as large as a water-pail, send it to me. But they are very large sometimes. The bone wen probably results from several causes. I have no doubt that thumping the stanchion, or an injury of some kind, is often the cause of this disease. There is another type of the disease that has received several names. The doctors have called it, from its appearance of flesh mixed with bone, *osteosareoma*, as though flesh and bone were being united. It is a cancerous type of disease, and apparently it is malignant. It is incurable in an animal when the bone is enlarged. But a little wen, a little lump on the outside, might be taken off by the use of iodine or alkali in solution, and farmers in Vermont tell me that soft soap, applied several days in succession, will reduce such a lump wonderfully. It could not be a bone difficulty if such an application had that effect. All sorts of things have been tried. Iodine is probably the best thing known for it. That is what physicians use for all scirrhus enlargements. An animal that has that disease in the large, well-developed type is surely out of condition. It reduces their flesh; they may be poor, and therefore their meat is unsavory,—not of that fine quality I speak of. But that it would produce any bad results, I should want evidence. I know that farmers slaughter animals affected in this way because they think they are growing worse, and eat the meat themselves. I do not think there is any proof that it is dangerous; but the meat cannot be of first quality, and I should rather have my meat from a perfectly healthy animal.

QUESTION. How about the milk?

Prof. CRESSY. Similar.

Mr. ———. I had an animal that had a bone wen, to which I applied copperas water, and it has all gone away now.

Prof. CRESSY. Copperas has a good effect as an absorbent, like iodide of potash, which would be preferable. But that it would prove a remedy if the wen had become attached to a bone, I question. In the case to which the gentleman refers it was probably a flesh affair; it had not got thoroughly settled on the bone.

Mr. WETHERELL. Is it not a fact that farmers frequently fatten animals that are attacked with that disease, and that they fatten well? I know that is the case. If the animal fattens well what objection is there to the use of that beef?

Prof. CRESSY. None, if you fatten it before the wen develops into a running issue. Before it breaks and begins to run the animal will fatten just as well as if it did not have this trouble. But it is not so, I think, when it begins to run.

Mr. CHEEVER. Will the Professor, while he is on the subject of wens, say something about swellings on the knees of animals?

Prof. CRESSY. Cows frequently have swellings on the forward knees corresponding to our wrist, of the white-swelling type, caused by injuries received in kneeling down on the floor, falling down on the knees, where they are not bedded so well as they might be. Not unfrequently, through the continued contusions that will occur in falling, you will find nature making an attempt to pad that knee. She throws out a large amount of secretion, and it will begin to pad it up; it will grow thicker and thicker, until there will be quite a large swelling. If you cut it open you may get as much as two quarts of matter from it, and you will find a large amount of diseased tissue about it. You can open it easily, squeeze the matter out of it, and sew it up. It will heal finely.

Mr. CHEEVER. Is it not better to let it alone entirely?

Prof. CRESSY. Well, I should not be paying a very high compliment to surgery if I advised you to let it alone; but in the advanced stages of it surgical treatment will not save it. In the case of a young, thriving animal it can be saved.

OFFICIAL LIST OF AGRICULTURAL SOCIETIES IN CONNECTICUT, 1879–80.

Name of Society.	President.	Secretary.	Treasurer.
Connecticut State,	E. H. Hyde, Stafford.	Burdett Loomis, Hartford.	F. A. Brown.
Hartford County,*	L. S. Wells, New Britain.	Warren Rowley, Hartford.	G. W. Wilson.
New Haven County,	J. J. Webb, New Haven.	C. P. Augur, Whitneyville.	R. B. Bradley.
New London County,	Willis R. Austin, Norwich.	Joab B. Rogers, Norwich.	F. L. Gardner.
Fairfield County,	J. E. Wheeler, Saugatuck.	Wm. D. Gregory, Norwalk.	Wm. A. Curtiss.
Windham County,	Alexander Warner, Pomfret.	Willard Day, Danielsonville.	A. Wylie.
Litchfield County,*	Harry Sedgwick, Cornwall Hollow.	D. C. Kilbourn, Litchfield.	E. C. Jones.
Middlesex County,*	J. M. Hubbard, Middletown.	G. W. Wilson, Middletown.	G. W. Wilson.
Tolland County,	A. McKinney, Ellington.	J. C. Hammond, Jr., Rockville.	E. S. Henry.
Bloomfield,*	H. G. Fish, Bloomfield.	J. E. Cox, Bloomfield.	H. W. Rowley.
Danbury,	John W. Bacon, Danbury.	B. C. Lynes, Danbury.	J. W. Bacon.
East Granby,	Almon Phelps, East Granby.	H. L. Clark, East Granby.	F. G. Granger.
Guilford,	Arthur S. Fowler, Guilford.	J. S. Benton, Guilford.	G. B. Spencer.
Harwinton,	C. S. Barber, Harwinton.	A. Webster, Harwinton.	A. Webster.
New Milford,	W. D. Black, New Milford.	Robert Erwin, New Milford.	Charles Randall.
Meriden,	L. P. Chamberlain, Meriden.	L. E. Coe, Meriden.	L. H. W. Yale.
Milford and Orange,	A. N. Clark, Milford.	E. G. Miles, Milford.	C. F. Smith.
Oxford,*	Joel White, Oxford.	R. S. Hinman, Birmingham.	C. H. Butler.
Pequabuck,	S. R. Gridley, Bristol.	Henry S. Pratt, Bristol.	H. S. Pratt.
Ridgefield,	Edward H. Smith, Ridgefield.	E. L. Smith, Ridgefield.	D. S. Sholes.
Suffield,	M. J. Sheldon, Suffield.	H. F. Fuller, Suffield	H. F. Fuller.
Tolland County East,	W. Holman, Tolland.	E. T. Converse, Stafford Springs.	R. S. Hicks.
Torrington,	E. H. Smith, Wolcottville.	C. James, Wolcottville.	C. James.
Union (Falls Village),	Charles Barnum, Lime Rock.	C. B. Maltbie, Falls Village.	O. M. Brinton.
Union (Somers, etc.),	Amos Pease, Somers.	John P. McKnight, Ellington.	C. M. Abbe.
Union (Monroe, etc.),	Agur S. Beach, Plattsvile.	Joseph Tomlinson, Birmingham.	S. H. Blackman.
Waterbury,	C. B. Webster, Waterbury.	C. N. Hall, Waterbury.	G. S. Parsons.
Watertown,	O. B. King, Watertown.	G. A. Woodruff, Watertown.	F. B. Hand.
Woodbridge and Bethany,	E. Beecher, Bethany.	S. G. Davidson, Bethany.	S. G. Davidson.
Woodbury,	D. S. Lemmon, Woodbury.	W. E. Scovill, Woodbury.	A. A. Root.
Woodstock,	S. O. Bowen, Woodstock.	H. T. Child, Woodstock.	E. T. Warner.

* No Fair.

RETURNS OF AGRICULTURAL SOCIETIES, 1879.—FINANCES.

SOCIETIES.	Amount received from State.	Membership and Fees.	Donations.	All other sources.	Receipts for the year.	Premiums offered.	Premiums and gratuities awarded.	Premiums and gratuities paid.	Current expenses for the year, not including premiums and gratuities.	Disbursements for the year.	Indebtedness.	Value of real estate.	Value of personal property.
Connecticut State,	$2,500.00	$2,185.46	....	....	$4,635.46	....	....	$1,759.00	$1,430.76	$4,189.76	....	....	....
New Haven County,	200 00	957.50	$50.00	$2,685.83	....	$3,000.00	$2,982.00	1,890.91	2,220.06	4,110.97	....	....	$279.76
New London County,	300.00	3,209.00	1,577.00	3,565.75	10,089.98	2,800.00	....	2,255.75	2,782.23	10,089.98	$6,371.51	$10,000.00	300.00
Fairfield County,	200.00	563.50	....	4,935.52	5,699.92	2,087.25	2,027.00	2,027.00	4,184.92	6,161.92	10,500.00	20,901.04	....
Windham County,	200 00	2,398.17	....	16.00	2,614.17	1,619.32	....	1,619.32	770.64	2,389.96	None.	3,500.00	370.00
Tolland County,	200.00	305.55	52.75	428.25	986.55	534.50	....	652.75	655.40	1,170.40	None.	2,000.00	100.00
Danbury,	100.00	5,997.80	....	1,018.53	7,115 83	3,178.00	2,803.50	2,754.00	2,909.15	7,092.32	None.	10,000.00	2,000.00
East Granby,	100.00	60.00	40.00	....	200.00	193.75	182.00	132.00	88.25	170.25	....	....	15.00
Guilford,	100.00	160.00	40.00	80.00	380.00	183.00	....	183.00	175.00	358.00	....	....	400.00
Harwinton,	100.00	20.00	24.00	171.50	315.50	68.00	49.00	117.00	193.92	310.92	....	....	164.53
Meriden,	100.00	1,181.26	....	156.23	1,437.59	1,457.00	1,029.25	1,029.25	536.18	1,565.43	None.	....	2,800.00
Milford and Orange,	100.00	327.00	....	1,124.57	1,551.57	825.25	671.00	650.50	574.61	1,225.11	250.00	....	1,200.00
Pequabuck,	200.00	313.58	2.00	83.25	598.83	374.25	....	....	140.25	478.86	None.	....	140.00
Ridgefield,	100.00	....	....	....	....	....	....	....	....	....	....	....	....
Suffield,	100.00	365.26	....	152.19	617.45	325.00	....	263.75	126.79	390.54	....	....	....
Tolland County East,	100.00	....	....	....	....	....	....	....	....	....	....	....	....
Torrington,	100.00	805.15	....	....	905.15	700.00	614.10	483.00	422.15	905.15	....	....	25.00
Union (Falls Village),	100.00	847.80	....	....	947.00	608.56	....	301.75	300.00	....	265.00	....	300.00
Union (Somers, etc.),	100.00	....	....	26.50	126.50	137.00	....	33.95	22.50	56.45	....	....	915.00
Union (Monroe, etc.),	100.00	1,231.55	6.50	221.00	1,559.05	726.50	716.50	699.50	306.59	1,509.38	1,000.00	2,500.00	49.67
Waterbury,	100.00	606.82	....	19.70	626.52	920.00	407.50	345.75	567.35	913.10	....	....	25.00
Watertown,	100.00	1,778.05	....	159.00	2,037.05	2,000.00	....	1,800.00	675.00	....	None.	....	500.00
Woodbridge and Bethany,	100.00	119.94	....	466.60	686.54	....	421.75	....	264.79	....	....	....	....
Woodbury,	100.00	419.62	....	100.00	619.62	611.50	446.88	377.41	201.11	....	None.	....	....
Woodstock,	100.00	1,415.19	....	313.15	1,828.84	1,208.75	....	1,028.47	400.00	....	800.00	5,625.00	10.00

NUMBER OF ANIMALS EXHIBITED.

Societies.	Bulls.	Milch Cows.	Heifers.	Calves.	Working Oxen (pairs).	Steers (pairs).	Fat Cattle.	Horses.	Sheep.	Swine.	Poultry (coops).	Other Stock.
Connecticut State,	...	...	...	...	...	...	...	...	...	...	...	...
New Haven County,	24	60	40	49	77	22	14	132	89	102	292	...
New London County,	45	114	77	26	80	18	20	47	96	15	24	...
Fairfield County,	12	14	16	4	41	5	6	75	56	...	...	...
Windham County,	25	57	49	48	89	77	4	101	119	44	81	...
Tolland County,	8	14	12	9	7	5	8	42	1	...	20	...
Danbury,	21	65	29	18	93	14	8	82	31	41	126	15
East Granby,	5	35	10	7	35	8	...	15	20	10	2	...
Guilford,	5	8	...	10	98	12	4	15	12	15	16	...
Harwinton,	6	4	3	7	124	62	4	15	35	50	6	...
Meriden,	18	64	54	16	28	37	8	166	25	7	85	8
Milford and Orange,	7	16	7	8	15	7	...	58	14	7	19	2
Pequabuck,	3	21	8	5	8	21	3	38	40	4	35	...
Ridgefield,	...	...	...	...	...	...	...	...	...	...	...	...
Suffield,	10	51	26	13	26	19	...	89	16	15	...	...
Tolland County East,	...	...	...	...	...	...	...	...	...	...	...	...
Torrington,	...	...	...	...	...	...	...	...	...	...	...	...
Union (Falls Village),	20	33	58	22	24	18	15	22	35	10	4	...
Union (Somers, etc.),	...	...	...	...	...	...	...	...	...	...	...	...
Union (Monroe, etc.),	16	...	...	38	115	21	6	70	25	...	58	...
Waterbury,	15	36	25	21	...	...	...	...	...	...	...	...
Watertown,	20	38	72	41	71	58	4	119	108	38	126	...
Woodbridge and Bethany,	15	...	44	...	8	8	7	26	12	3	54	...
Woodbury,	...	...	...	...	...	...	...	...	...	...	...	...
Woodstock,	33	60	56	20	15	15	5	100	12	21	77	...

ANALYSIS OF PREMIUMS AND GRATUITIES AWARDED.

FARM STOCK.

SOCIETIES.	Bulls.	Milch Cows.	Heifers.	Calves.	Working Oxen.	Steers.	Fat Cattle.	Horses.	Sheep.	Swine.	Poultry.	All other stock.	Total amount awarded for live stock.	Total am't paid for live stock.
Connecticut State	....	....	....	....	....	....	....	....	....	....	....	....	....	....
New Haven County,	$130.00	$193.00	$87.00	$38.00	$118.00	$38.00	$70.00	$1,022.00	$52.00	$104.00	$206.00	....	$2,107.00	$678.50
New London County,	114.00	159.25	85.00	29.00	102.00	39.00	....	1,198 00	110.00	48.00	75.00	....	....	....
Fairfield County,	28.00	11.00	24.00	8 00	73.00	11.00	16.00	189.00	....	24.00	59.00	....	393.00	393.00
Windham County,	80.00	105.00	59.00	51.00	140.00	75.00	13.00	556.00	42.00	21.00	89.00	....	1,231.00	1,231.00
Tolland County,	13.00	20.00	9.00	3.00	11.00	12.00	3.00	45 00	3.00	....	13.00	$24.00	156.00	156.00
Danbury,	52.00	185.00	32.00	12.00	177.32	32.00	11.00	1,246.00	36.00	68.00	95.00	21.00	1,964.00	1,964.00
East Granby,	7.50	30.50	6.00	3.00	21.25	5.00	....	22.00	5.00	5.00	1.00	....	106.00	106.00
Guilford.	4.00	5.00	....	1.75	25.00	4.00	3.00	15.50	3.00	5.50	9.00	....	75.75	75.75
Harwinton,	....	....	....	....	39.00	20.00	....	....	....	....	....	....	59.00	59.00
Meriden,	47.00	73.00	52.00	14.00	52.00	40.00	6.00	375.00	15.00	16.00	79.00	4.00	773.00	773.00
Milford and Orange,	6.00	18.00	5.00	2.50	33.00	8.50	....	419.00	3.00	10.00	18.00	.50	538.50	517.50
Pequabuck,	4.00	7.00	6.00	2.00	6.00	21.00	5.00	27.00	21.00	6.00	26.00	....	191.50	131.00
Ridgefield,	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Suffield,	9.50	11.50	12.00	7.00	9.00	6.00	....	20.75	3.00	3.00	....	14.00	95.75	96.00
Tolland County East,	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Torrington,	....	....	....	....	....	....	....	....	....	....	....	....	410.50	174.87
Union (Falls Village),	24.00	40.00	46.00	20.00	50.00	42.00	25.00	47.00	25.00	5.00	3.00	....	327.00	163.50
Union (Somers, etc.),	....	....	....	14.00	12.00	10.00	....	18.00	....	....	5.00	20.00	79.00	79.00
Union (Monroe, etc.),	....	....	....	30.50	139.00	21.50	11.00	260.00	14.00	11.00	19.50	....	526.00	516.00
Waterbury,	20.00	44.00	25.00	22.00	46.00	28.00	....	29 00	28.00	....	73.50	....	314.50	273.50
Watertown,	62.00	52.00	79.00	20.00	128.00	38.00	13.00	261.00	50.00	18.00	177.00	335.00	911.00	911.00
Woodbridge and Bethany,	18.00	....	40.50	....	12.00	11.25	13.50	66.50	14.50	3.00	25.00	....	204.25	204.25
Woodbury,	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Woodstock,	47.00	96.00	....	40.00	50.00	26.00	13.00	214.00	22.00	24.00	45.00	*45.00	642.00	642.00

*Town teams.

ANALYSIS OF PREMIUMS AND GRATUITIES—CONTINUED.

FARM PRODUCTS.

SOCIETIES.	Indian Corn.	Wheat.	Rye.	Barley.	Oats.	Beans.	Grass Seed.	Potatoes.	Carrots.	Beets.	Parsnips.	Turnips.	Onions.	Other root crops.
Connecticut State,	....	....	....	....	....	....	....	....	....	....	....	....	....	....
New Haven County,	$18.50	$6.00	$2.50	$1.50	$2.50	$10.00	....	$23.50	$3.00	$4.50	1.50	$9.00	$6.00	$9.50
New London County,	1.50	1.00	1.50	1.00	1.50	3.50	$1.00	5.00	1.00	3.00	1.00	1.50	....	....
Fairfield County,	5.50	4.00	2.50	1.50	1.50	....	....	15.00	1.50	1.50	1.50	....	4.50	....
Windham County,	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Tolland County,	....	....	.50	....	2.75	.25	....	8.50	.25	2.00	.75	1.25	.75	13.25
Danbury,	3.25	2.50	2.50	....	4.50	1.00	3.00	13.00	.75	2.00	.50	2.00	2.50	31.00
East Granby,	1.00	.50	.50	....	.50	.25	....	.50	.25	.25	.25	.25	.25	....
Guilford,	4.75	2.50	.75	....	....	3.00	....	7.25	.75	3.75	.50	3.50	3.50	14.75
Harwinton,	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Meriden,	5.50	3.00	2.25	1.75	2.25	1.75	....	7.50	1.50	4.00	1.00	2.00	4.50	21.25
Milford and Orange,	1.50	1.25	.75	.75	.75	.75	....	4.50	1.00	3.25	.75	....	3.00	4.00
Pequabuck,	1.75	2.75	1.50	....	....	.50	....	13.00	....	1.25	.25	1.25	.75	....
Ridgefield,	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Suffield,	3.00	....	....	....	....	....	....	8.00	.50	1.00	....	.50	....	2.00
Tolland County East,	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Torrington,	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Union (Falls Village),	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Union (Somers, etc.),	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Union (Monroe, etc.),	6.00	3.00	1.50	....	2.50	....	....	10.00	....	3.00	....	1.50	5.50	16.25
Waterbury,	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Watertown,	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Woodbridge and Bethany,	7.25	1.25	2.50	....	1.25	....	....	17.50	.75	4.25	.50	4.75	3.75	....
Woodbury,	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Woodstock,	4.25	3.25	2.50	1.50	1.75	2.50	....	9.00	....	3.25	1.00	3.50	....	....

ANALYSIS OF PREMIUMS AND GRATUITIES—CONTINUED.

FARM PRODUCTS.

SOCIETIES.	Total amount offered for Grain and Root Crops.	Total am't awarded for Grain and Root Crops.	Total amount paid for Grain and Root Crops.	Plowing at Exhibition.	Fruits.	Flowers.	Butter.	Cheese.	Honey, Maple Sugar, and Preserved Fruits.	Bread and Cake.	Total amount paid for Farm Products.	Amount awarded for Farm Implements.	Mechanical Inventions, Domestic Manufactures, etc.	Number of Diplomas.	Number of Medals.
Connecticut State,	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
New Haven County,	$70.00	$98.00	$49.00	*	$178.50	$157.50	$3.00	$4.00	$10.00	$22.00	$263.50	$63.00	$79.00	60	......
New London County,	......	......	......	$17.00	42.50	18.50	16.00	10.00	10.50	......	......	21.00	85.50	9	......
Fairfield County,	78.00	38.00	38.00	......	80.50	67.00	8.00	......	18.50	14.00	229.50	26.50	187.00	18	20.
Windham County,	......	42.25	......	......	56.42	48.00	14.00	14.00	12.00	9.00	195.67	31.00	183.80	......	......
Tolland County,	15.00	30.25	30.25	......	4.50	......	6.00	4.50	1.50	4.00	88.25	......	......	20	......
Danbury,	......	38.50	38.50	......	59.00	73.00	4.00	8.00	16.00	43.00	198.00	28.00	525.50	21	......
East Granby,	4.50	4.50	4.50	......	4.25	2.00	3.00	.50	1.50	.50	25.25	......	15.50	......	......
Guilford,	......	50.00	50.00	......	30.75	2.50	.75	.50	5.25	5.25	95.00	......	12.25	......	......
Harwinton,	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Meriden,	84.00	58.25	58.25	......	50.50	5.50	15.00	......	14.00	9.50	152.75	......	†43.50	......	......
Milford and Orange,	22.75	22.25	18.00	......	15.75	15.25	8.25	......	5.50	7.00	73.50	......	38.00	6	......
Pequabuck,	31.00	23.00	28.00	......	25.00	7.50	1.50	1.50	.25	2.75	61.50	......	44.00	......	......
Ridgefield,	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Suffield,	20.00	15.00	5.00	......	9.45	.45	2.25	......	1.00	1.50	14.10	5.00	29.25	......	......
Tolland County East,	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Torrington,	100.00	50.00	15.00	......	......	......	......	......	......	......	25.00	......	30.00	......	......
Union (Falls Village),	......	150.00	......	......	10.00	15.00	10.00	5.00	18.00	5.00	223.00	20.00	20.00	......	......
Union (Somers, etc.),	3.00	8.00	......	......	......	......	......	......	......	......	23.00	5.00	10.00	......	......
Union, Monroe, etc.),	......	52.25	49.25	......	60.50	11.00	6.00	3.00	5.00	12.00	146.75	......	48.75	......	......
Waterbury,	40.00	29.00	26.50	......	85.00	19.00	12.50	......	......	......	68.00	......	......	35	......
Watertown,	......	....	......	......	......	......	......	......	......	......	101.00	18.50	150.00	......	......
Woodbridge and Bethany,	......	......	......	......	52.00	13.25	2.50	2.50	7.50	3.25	124.75	......	......	......	......
Woodbury,	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Woodstock,	94.00	70.00	......	......	40.00	80.00	10.00	6 00	13.00	1.00	......	100.00	100.00	......	......

* Spading, $10.

† Trains of Oxen and Decorated Carts, $60.

OFFICIAL LIST OF FARMERS' CLUBS IN CONNECTICUT, 1879–80.

NAME OF CLUB.	PRESIDENT.	SECRETARY.
New Haven County,	J. J. Webb.	R. S. Hinman.
Bristol,	S. R. Gridley.	John Winslow.
Cheshire,	Charles S. Gillette.	N. S. Platt.
Chester,	A. H. Gilbert.	C. E Lord.
Clinton,	John P. Johnson.	Joseph H. Sperry.
Columbia,	Joseph Hutchins.	W. H. Yeomans.
East Windsor,	H. W. Allen, Jr.	John F. Fitts.
Guilford,	Sidney W. Leete.	R. H. Woodruff.
Hamden,	G. W. Bradley.	C. P. Augur.
Jewett City,	....	H. L. Reade.
Killingworth,	L. L. Nettleton.	Francis Turner.
Lebanon,	O. E. Pettis.	Wm. Huntington.
Meriden,	Oliver Rice.	Levi E. Coe.
Middlefield,	J. T. Inglis.	P. M. Augur.
Morris,	A. C, Tracy.	S. W. S. Skilton.
Mystic,	Jeduthun Whipple.	L. W. Crouch.
Naugatuck,	J. B. Tolles.	M. S. Baldwin.
Newington,	Heman A. Whittlesey.	John S. Kirkham.
North Stonington,	T. W. Wheeler.	F. S. Peabody.
New Britain,	L. S. Wells.	A. C. Blake.
Pomfret,	John Dimon, Putnam.	B. S. Warner.
Westbrook,	John A. Fiske.	O. H. Norris.
West Cornwall,	R. I. Scoville.	T. S. Gold.
Westport,	Wm. J. Jennings.	S. B. Sherwood.
Willimantic,	N. P. Perkins.	V. D. Stearns.
Wilton,	D. N. Van Hoosear.	D. H. Van Hoosear.
Woodstock,	John Dimon.	Dr. G. A. Bowen.

TREASURER'S REPORT.

NATHAN HART IN ACCOUNT WITH
THE STATE BOARD OF AGRICULTURE.

1879.		RECEIVED.		
Jan. 7,	1880,	By balance from old account,		$1,951.73
“ 2,	“	State appropriation,		2,500.00
				$4,451.73
		PAID.		
Jan. 16,	1879,	J. C. Capen,		$11.70
“	“	A. L. Avery,		37.50
“	“	H. L. Stewart,		52.93
“	“	T. S. Gold,		201.21
Jan. 17,	“	P. M. Augur,		100.00
Feb. 1,	“	J. M. W. Yerrinton,		143.50
“	“	Noah Cressy,		39.10
Feb. 17,	“	A. L. Avery,		20.00
“	“	T. S. Gold, for N. Cressy,	$27.00	
“	“	“ “ for Hartford Courant,	5.00	
“	“	“ “ for New Haven Register,	5.37	
“	“	“ “ for New Haven Palladium,	3.50	
				40.87
May 2,	“	W. O. Atwater,		250.00
July 6,	“	Burr Brothers,		6.00
Dec. 20,	“	H. L. Stewart,		15.86
“	“	J. M. Hubbard,		11.75
“	“	C. H. May,		32.00
“	“	J. T. Rockwell,		11.45
Dec. 27,	“	C. T. Hickox,		30.30
“	“	P. M. Augur,		24.00
“	“	W. H. Brewer,		27.25
“	“	J. Wetherell,		27.60
“	“	J. B. Olcott,		26.60
“	“	E. L. Sturtevant,		28.00
“	“	Albert Day,		37.70
“	“	J. M. Hubbard,		25.00
“	“	Juliet Corson,		25.00
Jan. 1,	1880,	Noah Cressy,		64.00

Jan. 2,	1880,	T. S. Gold,	Salary,	$700.00	
"	"	"	Traveling expenses,	242.75	
"	"	"	Cattle Commission expenses,	17.35	
"	"	"	Farm Committee expenses,	3.65	
"	"	"	Express,	36.73	
"	"	"	Postage,	48.84	
"	"	"	Telegrams,	11.43	
"	"	"	Stationery,	6.89	
"	"	"	Hotel bill at Willimantic,	55.09	
"	"	"	Expense of reporting,	20.00	
"	"	"	Dr. Cressy, lecture,	26.00	
					$1,168.53
Jan. 14,	"	James A. Bill,			29.25
"	"	J. J. Webb,			11.05
"	"	N. Hart,			31.00
"	"	The Case, Lockwood & Brainard Co.,			408.45
"	"	W. Holman,			18.35
"	"	E. H. Hyde,	Traveling expenses,		10.10
"	"	" "	Expenses on Cattle Commission,		255.01
"	"	" "	Services,		240.00
"	"	Cash in treasury,			990.72
					$4,451.73

NATHAN HART, *Treasurer.*

West Cornwall, January 14, 1880.

Audited and approved January 14, 1880.

J. T. ROCKWELL,
J. M. HUBBARD,
H. L. STEWART,
} *Auditing Committee.*

REPORT OF FARM EXPERIMENTS WITH FERTILIZERS, 1879.

BY PROF. W. O. ATWATER.

The report of the Connecticut Board of Agriculture for 1877 contained accounts of a number of field experiments with fertilizers suggested by the writer while director of the State Agricultural Experiment Station. At the request of the *American Agriculturist*, plans for similar experiments, with such alterations as experience had suggested, were drawn up, and proposed by that journal to its readers in the spring of 1878. At the same time the Vermont Agricultural College and the Maine State College of Agriculture and the Mechanic Arts introduced similar field trials, the latter upon its own farm, the former through the agency of a number of leading farmers of Vermont. Both these institutions also inaugurated some more complicated experiments, in which two gentlemen in this State also joined. The results were given in the Report of the Connecticut Board of Agriculture for 1878. The outcome of their continuance in 1879 is reported herewith.

For the details of the Vermont Agricultural College experiments, which are to appear in the report of the institution, I am indebted to the courtesy of Rev. M. H. Buckham, D.D., President. The report of the experiments of the Maine Agricultural College were kindly furnished by Prof. W. H. Jordan, whose fuller account of them is given in his report as professor of agriculture in the college.

The chief labor of arranging and tabulating the results of the experiments has been performed by my friend and assistant, Mr. G. P. Merrill, who has gone carefully through the reports and collated the results in the tables which follow. I have also looked over each report, reviewed the tabulations, and made notes of points of interest.

The *American Agriculturist* not only proposed the experiments to its readers, but also, with the hearty coöperation of several prominent and reliable dealers in fertilizers,* arranged to provide the materials at prices just covering cost. With each lot of fertilizers was sent a pamphlet, containing explanations and directions for the experiments, and blanks on which such of the experimenters as might care to take the needed trouble were requested to report the results.

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* The following firms coöperated in furnishing the materials: Messrs. H. J. BAKER & BRO., 215 Pearl street, New York; THE BOWKER FERTILIZER CO., 3 Park Place, New York, and 43 Chatham street, Boston; THE MAPES FORMULA AND PERUVIAN GUANO COMPANY, 158 Front street, New York.

Samples of the fertilizers were analyzed, and like all materials from the same firms which have been analyzed under my direction or of which I have seen analyses elsewhere reported, proved to be as represented.

I may say that both the journal which proposed the experiments and the parties who put up the fertilizers displayed a great deal of enthusiasm in the undertaking, doing this, as I happen to know, at pecuniary cost to themselves, and with no prospect of gain other than would come with the credit for encouraging the enterprise.

The experiments were made from Maine to Kansas, from Canada to Florida. As an application of science to farming by practical men, who get their living from the labor of their brains and hands upon their farms, and who have found in them a means of testing the needs of their soils, and the ways of supplying them, and who have made an important addition to the sum of our knowledge of the ways in which soils furnish plant-food and crops use it, I believe the accounts of their experience will be widely welcomed.

The present account naturally contains some repetitions of last year's statements. I omit, however, the details of plans and directions which may be found in that report.*

PURPOSE AND PLAN OF THE EXPERIMENTS.

The ostensible object of these experiments was to work upon farmers' soils. Underneath this lay, in my own thought, a deeper purpose, to work upon their owners' minds. And in this regard, at least, the outcome of three seasons' experience has been most gratifying.

The vast amount of work done in field experiments with fertilizers has clearly demonstrated the facts that:

1. Soils vary greatly in their capabilities of supplying food to crops. Different ingredients are deficient in different soils.

2. Soils fail to furnish enough food to crops, not so much because they have not abundant stores, as because the materials are not in available forms.

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* Report of Connecticut Board of Agriculture, 1878, pp. 357-365.

3. The deficiencies in many soils are due more to their physical condition, their texture and relations to heat and moisture, and to their lack of absorptive power, the power to hold plant food and not allow it to be leached away beyond the reach of the roots of the plants, than to their lack of plant food. Such soils want amendments first and fertilizers afterwards. Tillage improves the mechanical condition of the soil, while it also aids in rendering plant food available.

4. The chief office of fertilizers is to supply the plant-food which crops need and soils fail to furnish.

5. But the indirect action of fertilizers in improving the mechanical condition of the soil, increasing its absorptive power, and rendering its stores of plant-food available, is often of much more consequence than their direct action in supplying plant-food. Hence cheap materials, like lime and plaster, are often more profitable than farm manures or artificial fertilizers.

6. Plants vary greatly with respect to their capabilities for gathering their food from soil and air. Hence the proper fertilizer in a given case depends upon the crop as well as upon the soil.

7. It may be regarded as pretty well settled that the only ingredients of plant-food which we need to consider in commercial fertilizers are *Potash, Lime, Magnesia, Phosphoric acid, Sulphuric acid, and Nitrogen.* Of this list the magnesia is commonly, though not always, supplied in sufficient quantities in even "worn-out" soils. Sometimes its presence in fertilizers may be of considerable importance to crops. Sulphuric acid and lime are more often deficient, and hence one reason of the good effect so often observed from the application of lime and plaster. The remaining substances, the *Phosphoric acid, Nitrogen, and Potash,* are the most important ingredients of our common commercial fertilizers, because of both their scarcity in the soil and their high cost. It is in supplying these that guano, phosphates, bone manures, potash salts, and most other commercial fertilizers are chiefly useful.

8. It is not good economy to pay high prices for materials which our soils may themselves furnish, but it is good economy to supply the lacking ones in the cheapest way.

9. The only way to learn what materials are proper in a given case is by observation and experiment. The rational method for determining what ingredients of plant food a soil fails to furnish in abundance, and how these lacking materials can be most economically supplied, is to put the question to the soil with different fertilizing materials and get the reply in the crops produced.

10. The results of any given experiment are, in the main, applicable only to the particular case where it is made.

11. A single season's experimenting does not tell the whole story. To get complete results the trials must be carried through a series of years and crops.

To test the needs of the soils with respect to the chief ingredients of chemical fertilizers, phosphoric acid, nitrogen, and potash was the special, and the action of different fertilizing materials the general object of these experiments.

The directions recommended to have plans complete before starting; to select "worn-out" soils for soil tests, so that the action of the fertilizers might not be obscured by stores of available plant-food in the soil; to choose uniform soil and test its uniformity by duplicating the unmanured (or better the manured) plots; to lay out the plots accurately; to try lime, ashes, farm manures, and other materials along with the experimental fertilizers; to diffuse the fertilizers well through the soil; to make careful observations; to report fully; and, especially, to arrange to carry the experiments through a series of years and crops.

The Fertilizers Used in the Experiments.

Fertilizing materials were chosen which contain nitrogen, phosphoric acid, and potash, in forms shown by general experience to be appropriate and advantageous for use, to wit:

Nitrate of soda,	to furnish	Nitrogen.
Superphosphate,	" "	Phosphoric acid (with Sulphuric acid and Lime).
Muriate of potash,	" "	Potash.
Land plaster,	" "	Sulphuric acid and Lime.

The several materials in small bags were put up in sets. One, called "Acre Set," contained ingredients as below:

FERTILIZING MATERIALS.

ACRE SET.

Bag No.	KIND.	Amt.	Valuable Ingredients, per 100 lbs.	Cost pr. bag.
A.	Nitrate of Soda,..........	20 lbs.	Nitrogen, 15 per cent.	$1.00
B.	Dissolved Bone-Black,....	30 “	Phos. Acid, 15 “	.70
C.	Muriate of Potash,.......	20 “	Potash, 50 “	.60
D.	Nitrate of Soda,..........	15 “	Nitrogen, 5 “	1.40
	Dissolved Bone-Black,....	30 “	Phos. Acid, 10 “	
E.	Nitrate of Soda,..........	15 “	Nitrogen, 6.42 “	1.30
	Muriate of Potash,.......	20 “	Potash, 28.57 “	
F.	Dissolved Bone-Black,....	30 “	Phos. Acid, 9 “	1.25
	Muriate of Potash,.......	20 “	Potash, 20 “	
G.	Nitrate of Soda,..........	15 “	Nitrogen, 3.46 “	1.90
	Dissolved Bone-Black,....	30 “	Phos. Acid, 6.92 “	
	Muriate of Potash,.......	20 “	Potash, 15.38 “	
H.	Plaster,.................	20 “	....	.15
	Cost of “Acre Set,”..........			$8.30

The contents of each bag of the "Acre Set" were intended for a plot one-tenth of an acre. The eight plots thus fertilized, with two unmanured, or one unmanured and one with farm manure, thus make one acre. Another, "Half-Acre Set," containing the same materials, but in half the amounts, was also supplied at a cost of $5.00; a third, the same as the latter, with the omission of Nos. D, E, and F, was also offered at $3.00. The Acre Set was most strongly recommended; next to that, the Half-Acre Set. The majority of the experimenters took the Acre Set, and but very few of the partial sets (without D, E, and F,) were called for. With the materials of the "Acre Set," on one-tenth acre plots, and those of the "Half-Acre Set," on plots of one-twentieth acre, as directed, the amounts and costs per acre would be as follows. The calculations of cost allow market prices for the articles, plus $5.00 per ton for freight.*

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* The market prices of some of the materials have advanced somewhat since the above was written.

EXPERIMENTAL FERTILIZERS.

Number of Bag.	Fertilizer Used.				Furnishing Valuable Ingredients.			
	KIND.	Lbs. per acre.	At price per ton.	Cost per acre.	KIND.	Amount per cent.	Lbs. per acre.	Cost per acre.
A.	Nitrate of Soda,...	200	$75.00	$7.50	Nitrogen,.........	16 0	32.0	$7.50
B.	Dissolved Bone-Black,.	300	35.00	5.25	Phosphoric Acid,.	16.0	48.0	5,25
C.	Muriate of Potash,.....	200	45.00	4.50	Potash,...........	50.0	100.0	4.50
D.	Nitrate of Soda,........	150	48.40	10.88	Nitrogen,.	5.3	24 0	5.63
	Dissolved Bone-Black,.	300			Phosphoric Acid,.	10.7	48.0	5.25
E.	Nitrate of Soda,........	150	58.00	10.13	Nitrogen,.........	6.6	24.0	5.63
	Muriate of Potash,.....	200			Potash,...........	28.6	10.0	4.50
F.	Dissolved Bone-Black,.	300	39.00	9.75	Phosphoric Acid,.	9.6	48.0	5.25
	Muriate of Potash,.....	200			Potash,...........	20.0	100.0	4.50
G.	Nitrate of Soda.........	150	47.32	15.38	Nitrogen,.........	3.7	24.0	5.63
	Dissolved Bone-Black,..	300			Phosphoric Acid,.	7.4	48.0	5.25
	Muriate of Potash,.....	200			Potash,...........	15.4	100.0	4.50
H.	Plaster,................	200	8.00	.80	....	.....	......	.80

THE REPORTS AND THEIR VALUE.

The plans were drawn up on condition that if any of the experimenters chose to report their results, the accounts should be sent to me for examination. For this purpose blanks were sent with request to fill and return. The blanks were sheets of paper about 12x19 inches, with space for noting on one side, description of soil, subsoil, etc.; previous treatment, manuring, and yield; weather during experiment; fertilizers, and how applied; method of sowing, planting, tillage, etc.; and other details and remarks. The other side was devoted to details of size of plots, dates of planting and harvesting, amounts, quality, and value of produce in grain, roots, tubers, stalks, etc., by pounds and bushels; calculated profit or loss, etc. Nearly seventy of these reports are before me. Some are brief, most are well filled, and many entirely so, while several have additional interesting and suggestive statements covering a number of pages of foolscap, for which there was not room on the blanks.

I remarked in the last year's account that in accuracy and fullness of detail these reports exceeded my expectations. The blanks of this season call for still more detail than those of last year, but the number of reports is larger, and the quality is no less satisfactory. Working over them gives one a happy idea of farmers' intelligence and earnestness.

What the Reports Say—Failures and Successes.

Like last season's reports, some have no decided story to tell, and some none at all, except failure everywhere. Some were on land so rich that the action of the fertilizers was obscured by the stores of plant-food in the soil; others on soil evidently in such physical condition that no fertilizers could be effective. Crows, cows, cut-worms, grubs, and Colorado beetles worked the injury or ruin of quite a number; frost, heat, and drouth a number more. In several the fertilizers were applied so close to the seed as to injure or destroy the crop. In some cases it was found, while the crops were growing, that the land was uneven; the plots on one side were drier than on the other, or one plot was on an old sod, or showed the effects of previous manuring, while some were irregular for reasons that neither the experimenters nor the reports throw any light upon. Some of the experiments were made in ways which, though meeting the author's wishes, do not admit of tabulation. Some of the reports are so defective as to impair or destroy their value.

The fact is that these experiments are subject to all the natural vicissitudes of ordinary farming, and to a good many others besides, that come from lack of care, experience, or understanding of how to make them, or patience in their execution.

But a great many have a straight story to tell, and tell it on every plot. And some, which in themselves seem the least decisive, are in reality the most instructive of all.

In tabulating the results, I have excluded a large number; some because there were no unmanured plots; others, because of some irregularities which made them seem unreliable; and have given only those which bore upon the face evidence of accurate work, and in which no disturbing causes were apparent.

Results of the Experiments. The Tables.

Before discussing the details I give a general summary of results in Tables I and II, which follow. In computing these the same rules have been followed and remarks may be made as in last year's report.

1. The figures given by the experimenters are followed in all cases except the very few in which minor mistakes were apparent.

2. In some cases the materials were applied to areas different from those recommended. The variations thus made in the

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No.

HER CRO

	B.	C.
	Dissolved Bone-black, 300 lbs.	Muriate of Potash, 200 lbs.*
	Phosphoric Acid, 48 lbs.	Potash, 100 lbs.
	$5.25	$4.50
	bu.	bu.
	38	73
	62	33
	91	46
	136	49
	175	215
	152	140
	67	66
	52	72
	69	38
	110	175
	184	105
.3	88.8	85.2
.0	128.4	129.6
.3	45.6	10.0
.0	4,400.0	1,100.0
.9	32.5	25.6
...	....	....
..	14,520.0	....
.2	3.8	2.2

† Numbers 32 a

ndful in hill, 270 bu
, 220 bushels potato
, 50 bushels; 300 lb

amounts per acre, though considerable in some cases, do not materially affect the general result when all are averaged together.

3. The estimates for pounds per bushel of corn and potatoes vary considerably. Corn was generally weighed in the ear, and the shelled corn computed, the different experimenters allowing from seventy to eighty pounds of ears for one bushel of shelled corn. Where the ears were measured, two bushels are generally reckoned equal to one of shelled corn. I am inclined to think that generally too little allowance was made for the shrinkage that comes in curing. It is evident that the poorer yields appear to an unfair advantage in this way, unless the different qualities of produce are sorted. With corn, for instance, the small yields—those on the unmanured plots and with inefficient fertilizers—would have much larger proportions of poor corn than the good yields. A bushel, or seventy-five pounds of poor ears, would give less shelled corn than the same amount of good corn. The small errors thus introduced in the tables appear to the advantage of the poorer fertilizers in the comparison.

I suppose that but few of the gentlemen whose reports are before me are used to accurate experimenting, and there are doubtless many sources of error in their work which experience in methods of accurate research and more adequate appliances would have eliminated. Several in particular occur to me. One, as above said, is that the statements of results of weighings and measurements often fail to make due allowance for the quality of the crop. Another is the lack, in the majority of the cases, of unmanured spaces between the plots to prevent the roots of one from feeding upon the fertilizers of the other. Another is the unevenness of the soil, and a fourth, improper application of the fertilizers.

For that matter, I can see many imperfections in this method of experimenting. But if we work in the right spirit, experience will be our best teacher, and our errors our most effective lessons. Indeed it seems to me that these trials are only the beginning of what may be developed into work of the greatest value.

In connection with the figures for produce per acre in the tables, Mr. Merrill has tabulated a summary of descriptions of soil and weather, of which details are given in the special (extra) copies of this report (see page 402).

The tables will repay careful study. For instance, in the experiment of Mr. Bartholomew of Connecticut, No. 2, the 150 lbs. per acre of nitrate of soda, (A) costing $5.62½, brought no increase of corn; 300 lbs. of dissolved bone-black (B) added nearly 29 bushels at a cost of $5.25; while the two together (D) added 33 bushels at a cost of $10.88, and 150 lbs. of muriate of potash with these making the "complete" chemical fertilizer (G), increased the yield by 38 bushels, at a cost of $15.38.

In the experiment of Mr. Atwood of Connecticut, No. 6, this last mixture (G), increased the yield by 72 bushels. While this complete fertilizer was so profitable in No. 6, and the Superphosphate in No. 2, in No. 24 the muriate of potash (C) was most profitable, bringing about the same increase alone as with the other materials. In Nos. 1 and 7, all the fertilizers failed; in No. 1 apparently because of drouth; in No. 7 for some unexplained reason. Taking the average of the experiments for 1878 and 1879, the "complete" chemical fertilizer brought the largest crops of both corn and potatoes, excelling the farm manures. The mixture of superphosphate and potash salts brought nearly as large yields of corn and larger of potatoes than the farm manures. As to average profit, among the chemical fertilizers the complete fertilizer (G) paid best for potatoes, and the mixture of Superphosphate and Potash Salts (F) for corn.

SOILS IN WHICH THE SUPERPHOSPHATE WAS ESPECIALLY EFFICIENT.

Among the corn experiments, Table I, that of Mr. Bartholomew of Connecticut, No. 2 shows very strikingly the effect of the phosphoric acid. Every plot without it failed—every one with it gave a fair yield. The crop responded uniformly to the superphosphate and paid very little heed to nitrate of soda, muriate of potash, or plaster. Mr. Dow of Vermont, No. 30, Table II, had a similar experience with potatoes, though as is usually the case, the potatoes were more sensitive to the action of the nitrogen and potash. In the experiments of Messrs. Spalding, No. 7, Bourne, No. 9, Dow, No. 17, and others, the effect of the superphosphate is marked, though the crops in some are more or less helped by the other materials also.

On the other hand there were numerous cases, as Nos. 5, 13, 24, in which the superphosphate was of very little avail.

SOILS IN WHICH POTASH SALTS WERE MOST EFFECTIVE.

In Mr. Sage's experiment with corn, No. 24, the potash salts brought a large increase in every instance, while neither of the other materials had any marked effect in any case. In a similar experiment on an adjoining field last year, the potash salts paid more than tenfold their cost. In the experiments of the two years the mixture of superphosphate and potash salts, which Mr. Sage estimates as costing, applied, no more than the simple hauling of barn manure to some of his fields, has brought from sixty to seventy bushels of shelled corn per acre. Mr. Sage has also tried fine bone and potash salts for other crops, potatoes, oats, and even wheat, with equally satisfactory results. The effect of the potash salts was also uniformly large in Nos. 6, 15, and 22. With potatoes the potash salts were still more efficient. But as was the case with the superphosphate there are a number of experiments, as Nos. 2, 3, 13, 16, and 25, in which the potash salts were either inefficient or positively harmful.

CASES IN WHICH NONE BUT COMPLETE FERTILIZERS WERE SUCCESSFUL.

A notable case of this sort is that of Mr. Atwood, No. 6. The unmanured soil gave as good as nothing, the partial fertilizers brought varying amounts, that with the mixture of superphosphate and potash salt rising to forty bushels of shelled corn per acre. But the complete chemical fertilizer, the barn manure and the compost gave from eighty to ninety bushels each per acre. There are, however, no other instances in either this year's or last year's experiments in which the differences between the complete and the partial fertilizers are as striking as here, though there are many in which the complete fertilizer greatly excelled all the others. With corn it was frequently, and with potatoes generally, the most profitable of all.

CASES IN WHICH ALL THE FERTILIZERS FAILED

are not uncommon. In some, as Nos. 1, 16, 19, and 33, the failures seem to be due to drouth; in others, as No. 8, the reason does not appear from the report.

SPECIFIC EFFECTS OF THE DIFFERENT FERTILIZING MATERIALS IN THE DIFFERENT EXPERIMENTS.

To make these plainer, Mr. Merrill has prepared what we have got in the way of calling a "Table of Differences," TABLE III, herewith, which shows very clearly the effect of each material—nitrate of soda, superphosphate, and muriate of potash—both when used alone and when mixed with others. The effect of nitrate of soda alone is calculated by subtracting the average yield with no manure from that of the nitrate of soda plot. To find its effect with superphosphate, the yield of the phosphoric acid plot is subtracted from that which had the mixture of the two. The increase with the complete fertilizer over that with the superphosphate and potash salt, gives the effect of the nitrate of soda again, and so on. Of course it is understood that these differences in a given case do not express exactly the effect of the nitrogen, phosphoric acid, or potash, nor even that of the fertilizer containing them. The indirect action of the fertilizer counts for something, and the irregularities in the different plots often a good deal more. Indeed, one of the most interesting uses of this table is to show the uniformity or lack of uniformity of the action of the materials on the different plots, and, hence the reliability of the experiment. In No. 2, for instance, the plot with nitrate of soda shows 0.7 bushels less corn per acre than that with nothing, while the increase with nitrate of soda on the other plots over the corresponding plots without it is little or nothing. But when we come to the superphosphate we find an increase of from twenty-eight to thirty-eight bushels every time. The potash, on the other hand, brings either a small increase or a decrease on every plot. The results here are very uniform. But in other experiments as No. 37, the figures are very far from uniform. This test of the uniformity of an experiment is a severe one. Any irregularity in the soil or other circumstance that changes the yield of one plot from what it should be, is brought into full relief, and even exaggerated by these subtractions, and is further multiplied by ten or twenty, or even more in calculating from small plots to yield per acre.

One thing that surprised me in the table of differences of last year's experiments was the uniformity in the general averages. Thus, in the average of twenty-six experiments with corn, the several figures for increase with nitrate of soda over no manure, nitrate of soda plus superphosphate over superphosphate alone, and so on, were almost identical, and the same was true with the superphosphate and with the potash salt. The results this season are more variable. The reason is, I think, in part at least, not far to seek. A large number of this season's experiments suffered from bad weather. In drouth the chemical fertilizers are apt to injure the crops. This is especially the case with the nitrate of soda and the muriate of potash, and they seem to work the most harm when mixed together. A large number of the irregular cases can

EFFECTS OF HORIC ACID (WITH

REASE WITH MURIATE OF POTASH.

GROUPING OF SOIL (By yields without manure. H soil of each group above, and I below.)	Potash, 100 lbs., + Nitrogen, over Nitrogen alone.	Potash, 100 lbs., + Phosphoric Acid, over Phosphoric Acid alone.	Potash, 100 lbs., + Nitrogen + Phosphoric Acid, over Nitrogen + Phosphoric Acid.	Average increase from Potash.
POOREST SOILS. Yielding under 20 bushels o shelled Corn per acre withou Manure.	—7.4	—2.7	0.9	—2.6
	—0.3	5.5	4.3	2.2
	2.8	4.7	1.7	3.1
	—9.8	—4.9	2.1	6.5
	—19.2	—4.5	11.0	—7.9
	23.5	16.9	41.5	25.8
	3.7	5.1	8.9	4.9
	—1.2	—3.3	—3.0	—1.9
	0.5	3.8	22.5	9.8
	32.5	43.3	24.6	33.0
	2.9	7.3	8.9	6.3
MEDIUM SOILS. Yielding 20–30 bushels shelle Corn per acre without Manure	—1.7	—4.8	—6.7	—6.5
	22 0	4.6	—17.6	4.8
	1.2	—2.5	8.7	2.3
	5.8	6.7	10.5	11.5
	25.1	5.2	25.2	16.7
	10.6	1.8	4.0	5.7
BETTER SOILS. Yielding 30–40 bushels shelle	—6.3	2.5	—8.8	2.7
	6.0	—20.0	—6.0	—4.5
	0.1	2.9	—9.9	2.1
	7.5	—5.7	—0.1	0.4
				0 4

be explained in this way, and I think the effect is apparent in the averages. A further reason, I mistrust, is the fact that a larger portion of the experiments were on small, one-twentieth acre plots.

This table of differences seems to me well worth study. I find myself referring to it always, and generally to it alone when I wish to find whether an experiment is uniform and reliable, and what are the effects of the fertilizers.

SUMMARY OF RESULTS OF EXPERIMENTS.

Perhaps I may best summarize the results of the experiments as shown in the table, and at the same time compare them with that of 1878 by quoting from last season's report.

1. From the "table of differences" of 1878 it appeared that "the effects of the different materials on the poorer soils were generally very uniform. On the better soils they were more varied. This fact supports the view that the experiments are generally reliable as tests of the wants of worn-out soils, those which have only their natural strength to rely upon, but are not to be depended upon for rich soils, those that have an accumulated store of plant-food to draw from." This year's results are similar. On the poorer soils the increase from the same fertilizing material on the different plots of each experiment is pretty nearly uniform, while some of the results on the better soils are extremely irregular. But some of the latter are very regular, and some of the former very irregular.

2. In 1878, while the effects varied in individual cases, the agreement in the general averages of all the experiments was very striking. Thus in the average of the twenty-seven corn experiments, the increase caused by the nitrate of soda on the different plots ranged from 5.6 to 5.8 bushels per acre; that with the superphosphate from 8.7 to 9.6 bushels, and that with potash from 8.7 to 9.4 bushels." This season's results as above stated are less regular.

It is commonly stated that superphosphates, potash salts, and other like materials are more effective when used together than separately. That complete fertilizers are more reliable and effective than partial fertilizers is very certain. But if it is meant that the increase from the use of a given material, as potash salt, is greater when it is applied with other fertilizers than alone, the assertion is not supported so decidedly by these experiments. Still, on the whole, the balance is in favor of the use of mixtures.

This has been especially true in the experiments with potatoes. Here nitrate of soda, superphosphate, and muriate of potash have each been much more efficient in the complete fertilizer than alone or in the partial fertilizers.

3. *Nitrate of Soda* in 1878 "did best, where it was used with the other materials, on potatoes. Alone on potatoes, and alone or with other materials on corn, it was not often profitable." In 1879 the results were similar.

I confess some disappointment in the outcome with nitrate of soda. I had expected to see more decided benefit from its use on rich soils. In Europe, where "high farming" is customary, and more manure is applied and soils are generally kept in much better condition than here, nitrate of soda is very much used alone as a sort of stimulant to help crops to utilize the stores of plant-food in the soil.* In an extensive series of experiments with potatoes performed on a number of farms in the richly cultivated district near Halberstadt, (province of Saxony,) Prussia, under the direction of Dr. Märcker, nitrate of soda proved more profitable than guano, or superphosphate, or any mixture of these with each other, or with the nitrate of soda—a result which Dr. Märcker attributes to the high condition of the soils experimented upon. From such facts, gathered from general observation, I had been led to expect the best effects from the nitrate of soda on the richest soils, but in these experiments it has not been much more effective on these than on the medium or poorer soils. The discrepancy may possibly be explained by the fact that the soils classed here as best, namely those which brought the largest yield without manure, do not necessarily contain the largest stores of available mineral plant-food.

4. *Superphosphate* in 1878 "was profitable for corn, usually, and for potatoes in nearly every case. It was most useful on the poorer and medium soils. With corn, on the rich soils it had less, and sometimes almost no effect." Excluding the cases in which the weather was unfavorable, the effect of the superphosphate in 1879 was similar, save that the average effect on the best soils was better than in 1878.

5. *Plaster.* In 1878 "the effect was variable, but generally

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* Dr. Thoms, director of the Experiment Station at Riga, mentions a practice of the farmers in the Province of Saxony, Prussia, of applying nitrate of soda near the expiration of their leases, in order to get the benefit of the mineral food the soil contains before they leave.—*Bericht der Landw. Vs. Station, Riga.* III, 1879, 161.

amounted to little; though considering its small cost, at the rate of 200 lbs. per acre, on the average, it considerably more than paid for itself. The increase with corn was from none to 29, average 14⅓ bushels; with potatoes none to 33, average 12⅔ bushels. It is clear that some, though in most cases not much, of the effect of the superphosphate was due to its sulphuric acid and lime." The results in 1879 were very similar. The increase with corn ranged from none to 38 bushels per acre, average — bushels; with potatoes from none to 20, average — bushels. The most marked cases of good effect of plaster was in Mr. Stevens' experiment with corn, No. 20, in which the yield with plaster was at the rate of 72 bushels per acre, against 67 with superphosphate and 33 with no manure. Mr. Stevens says in his report, "The plaster was not applied until the second cultivating. The effect was almost instantaneous. The corn turned dark, began to grow and look different from the others. I think this was an exceptional season as regards plaster. I never saw it seem to do so much good."

6. *Muriate of Potash* in 1878 "proved profitable with corn frequently, and with potatoes in every case but two. The benefit, if any, was apt to be striking. I am persuaded that in the heavy clay its good effect must have been due, in good part at least, to its direct action; *e. g.*, in loosening the soil by precipitating the gelatinous clay, or otherwise improving its mechanical condition, and by rendering other plant-food available. Contrary to the common doctrine, the potash salts did not prove more efficient with other fertilizers than when used alone. Of course the crops were larger when other materials were added."

This season, again, the muriate of potash was profitable in more than half of the corn experiments and in all the potato experiments but two, in both of which drouth prevailed. With corn the muriate both seasons averaged as efficient by itself as with the other materials. But with potatoes its best effects were in the complete fertilizer.*

It is noticeable that in cases of drouth, or where the fertilizers were applied in the hill or drill, both the muriate of potash and the nitrate of soda were often injurious. With the mixture of the two this was especially the case.

7. *The complete fertilizer* in 1878 "brought by far the largest

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* See "Specific Effects of the Materials," above.

average crops, excelling by a considerable the farm manure. But the most profitable fertilizers were the partial ones, which fitted the demands of the special cases." The same was true in 1879, though it may be added that with potatoes the complete fertilizer was in both seasons the most profitable of all.

8. *Effects of the fertilizers on different kinds of soil.*—The experiments of 1878 did "not give data for many reliable inferences as to the kind of soil most benefited by the fertilizers. It may be said that on the heavy soils of the poorer classes the muriate of potash seemed to have a better effect than on the lighter soils of the same classes, and that the superphosphate produced a decidedly larger average increase on the two poorer than on the two better classes of soils. Though the superphosphate showed its best effects on corn, yet on soils yielding, unmanured, over twenty-five bushels per acre, the crop was seldom increased to any amount, and generally got little or no good from it. In other words, the superphosphate generally helped corn very decidedly on poor soils, but did little good on rich soils."

The results in 1879 are if anything less decisive than those of 1878. Indeed, without more and more definite data than are given by these or any other field experiments I have ever known of, I see no prospect of getting at any reliable generalizations as to the kinds of soils on which such fertilizers are or are not beneficial. The fact is that the circumstances of composition, texture, absorptive power, and relations to moisture and heat of the soils; of climate and season ; of previous tillage, manuring, and crops; are so complex and variable that no such empirical experiments as it is possible to carry on in field culture can bring full and definite information as to the ways in which soils and fertilizers supply food to plants or otherwise affect their growth. These problems must be also studied by the more accurate methods and with the control of conditions which are possible only in culture on a small scale, in the greenhouse or garden, and with the appliances and help of the laboratory.

9. *Feeding capacity of the plants.*—The experiments of 1878 indicated that corn was most aided by mineral fertilizers and was but little helped by nitrogenous manures, while potatoes responded well to all. This will be discussed farther on.

10. The dominant factor of the growth of the crop, of the good it gets from the manure, is the soil. Next to this come climate and season, next the feeding capacity of the plant, and

finally the composition of the plant. Such was the inference from the trials of 1878, and those of 1879 tell the same story.

Continuations of the Experiments through Successive Years.

I have insisted upon nothing more strenuously than the need of repeating the same trials with the same fertilizers on the same plots through series of years. This involves labor and expense. Several of the experimenters, however, have repeated their experiments of 1878 in 1879—some on the same plots, and others elsewhere on their farms. Table IV (next page) gives some of the results.

EXPERIMENTS ON THE FARM OF THE MAINE AGRICULTURAL COLLEGE.

The experiments of Profs. Farrington and Jordan of the Maine Agricultural College show decidedly beneficial results from the use of potash on beans and corn in 1878 and on potatoes in 1879, while the potash salts did not seem to help the rutabagas so much. In fact the rutabagas responded uniformly and largely to the phosphoric acid in every trial, and paid less attention to the other ingredients, though the nitrate of soda increased the yield materially.

In last year's report an account of a special corn experiment by Prof. Farrington was given. (See Expt. A, 1878, in "Special Nitrogen Experiments" Tables V and VI, pages 381, 383.) This was made alongside those just referred to, and was likewise repeated with the same fertilizers on the same plots in 1879, but unfortunately early frosts prevented the corn from maturing. In 1878 the corn responded profitably to the superphosphate and potash salt, but not to nitrogen in nitrate of soda, sulphate of ammonia, dried blood, or Peruvian guano. Prof. Jordan informs me that the results this season, so far as they could be estimated, agreed closely with those of last year. Full details of these experiments are given by Profs. Farrington and Jordan in the Reports of the Maine State College, and are not in place here.

Prof. Jordan proposes to continue these experiments in future years. Being upon a typical clay soil, so extensively duplicated, and under such excellent direction, the outcome in the future cannot fail to be very valuable.

MR. BARTHOLOMEW'S EXPERIMENTS,

which have now continued for three years, covered nearly one hundred plots, been repeated on the same plots, with the same fer-

TABLE IV.

REPETITIONS OF EXPERIMENTS OF 1878 IN 1879.

		Number of Plot,..........			O	A.	B.	C.	D.	E.	F.	G.	H.	
		KINDS AND AMOUNTS OF FERTILIZING MATERIALS APPLIED PER ACRE.			No Manure.	Nitrate of Soda, 200 lbs.	Dissolved Bone-Black, 300 lbs.	Muriate of Potash, 200 lbs.	Nitrate of Soda, 150 lbs. Dissolved Bone-Black, 300 lbs.	Nitrate of Soda, 150 lbs. Muriate of Potash, 200 lbs.	Dissolved Bone-Black, 300 lbs. Muriate of Potash, 200 lbs.	Nitrate of Soda, 150 lbs. Dissolved Bone-Black, 300 lbs. Muriate of Potash, 200 lbs.	Plaster, 200 lbs.	Farm Manure.
Prof. J. R. Farrington,	Corn repeated on same plots in 1879.	1878,	No. A,	Corn, bu.,	20.3	19.3	29.1	32.9	37.0	42.9	39.0	39.8	.....	34.8
Prof. W. H. Jordan,	Three crops of 1878 side by side in one experiment. In 1879 experiment repeated with potatoes, same fertilizers on same plots.	1878,	No. 37,	Beans, lbs.,	540.0	660.0	630.0	765.0	690.0	990.0	600.0	750.0	540.0	810.0
				Corn, bu.,	38.5	44.5	42.0	63.0	62.0	69.0	42.5	58.0	40.0	68.5
				Rut'b'ga, bu.,	225.0	285.0	315.0	240.0	428.0	203.0	413.0	518.0	263.0	300.0
		1879,	No. 27,	Potatoes, bu.,	37.0	49.0	38.0	73.0	47.0	59.0	111.0	129.0	35.0	116.0
W. I. Bartholomew, Conn.,	Experiments of 1878, on different parts of same field. Experiments of 1879, side by side on land adjoining Corn experiments of 1878.	1878,	No. B,	Corn, bu.,	17.7	18.7	39.9	19.1	41.9	21.1	43.1	51.7	......	49.8
		1878,	No. 27,	Potatoes, bu.,	180.0	162.0	200.0	125.0	210.0	......	220.0	250.0	150.0	.....
		1879,	No. 2,	Corn, bu.,	7.7	7.4	36.5	7.7	41.4	7.1	42.0	45.7	......	36.0
				Potatoes, bu.,	38.0	32.0	62.0	33.0	96.0	42.0	98.0	109.0	......	36.0
Dr. H. A. Cutting, Vt.,	Same fertilizers on same plots both seasons.	1878,	No. 33,	Potatoes, bu.,	30.0	40.0	80.0	20.0	100.0	60.0	100.0	140.0	60.0	80.0
		1879,	No. 33,	Oats, bu.,	15.6	15.3	45.6	10.0	58.7	54.4	28.1	40.0	27.8	26.9
S. H. Rising, Vt.,	Same fertilizers on same plots both seasons.	1878,	No. 18,	Corn, bu.,	27.5	51.9	40.0	49.1	47.1	52.4	47.7	53.7	40.0	52.6
		1879,	No. 36,	Potatoes, bu.,	80.0	105.0	110.0	175.0	94.0	125.0	80.0	145.0	90.0	120.0
C. Sage, Conn.,	Contiguous fields of same farm, similar soil.	1878,	No. C,	Corn, bu.,	11.8	21.5	16.5	62.3	11.2	68.9	70.3	84.0	......	43.8
		1879,	No. 24,	Corn, bu.,	42.0	49.2	46.0	59.0	41.1	58.0	63.4	60.8	......	.....
J. J. Dearing, Ga.,	Different fields.	1878,	No. 5,	Corn, bu.,	5.5	7.5	10.7	7.8	18.4	......	14.5	18.5	9.4	.....
		1878,	No. 4,	Cotton, lbs.,	104.5	38.5	242.0	66.0	599.5	......	457.0	698.0	44.0	.....
		1879,	No. 40,	Cotton, lbs.,	.....	.....	.....	.....	1,204.0	819.0	1,035.0	1,023.0	......	.....
C. Miller & Son, Vt.,	Different fields.	1878,	No. 14,	Corn, bu.,	20.2	40.5	57.2	30.0	67.9	......	71.0	70.5	23.0	60.0
		1879,	No. 13,	Corn, bu.,	21.9	27.5	33.7	23.7	30.0	31.2	28.7	38.7	34.7	....
Edward Hicks, L. I.,	Different fields.	1878,	No. 24,	Corn, bu.,	49.2	60.0	54.0	37.8	54.8	......	57.8	76.0	48.8	66.8
		1879,	No. 22,	Corn, bu.,	32.5	53.3	54.5	59.6	69.6	32.2	76.5	32.7	58.7	55.8
Buel Landon, Vt.,	Different fields.	1878,	No. 2,	Corn, bu.,	7.0	17.5	10.3	9.2	16.5	15.0	18.6	13.5	14.4	48.6
		1879,	No. 4,	Corn, bu.,	19.7	24.2	22.8	11.0	31.3	27.3	14.0	33.4	25.8	18.0

tilizers and the same crop, year after year, and on other parts of the same field, and on contiguous fields with other crops, are decidedly the most instructive and valuable ever made, to my knowledge, by a private individual in this country. They include

1st. An experiment with corn on ten plots, which has continued through three years with the same fertilizers on the same plots.

2d. An experiment with potatoes, reported last year.

3d. A "Special Nitrogen Experiment with Corn," reported in full last season, and recapitulated as "Expt. B, 1878," in "Special Nitrogen Experiments," Tables V and VI.

4th. A "Special Nitrogen Experiment with Corn and Potatoes, side by side," "B, 1879," in Table V and VI.

5th. Numerous other trials, not reported here.

I will first refer to his experiments with corn, begun in 1877, and continued on the same plots for three years. The plots were 10 square rods each. The fertilizing materials were:

No. of Plot.	FERTILIZERS.				FURNISHING VALUABLE INGREDIENTS.			
	KIND.	Lbs. per Acre.	At price per ton.	Cost per Acre.	KIND.	Assumed per cent.	Lbs. per Acre.	Cost per Acre.
1	Dried Blood..........	320	$40.00	$6.40	Nitrogen,.........	10	32	$6.40
	Dissolv'd Bone-black,	320	35.00	5.60	Phosphoric Acid,.	16	51	5.60
	Muriate of Potash,...	320	45.00	7.20	Potash,...........	50	160	7.20
	{ Dried Blood,.	160	37.50	6.00	{ Nitrogen,.........	5	16	3.20
	{ Dissolv'd bone black,	160			{ Phosphoric Acid,.	8	25½	2.85
	{ Dried Blood,.........	106⅔	40.00	6.40	{ Nitrogen,.........	3.3	10⅔	2.13
	{ Dissolv'd bone-black,	106⅔			{ Phosphoric Acid,.	5.3	17	1.87
	{ Muriate of Potash,...	106⅔			{ Potash,...........	16.7	53⅓	2.40
	Plaster,.............	320	10.00	1.60	....	....	....	....

Wood ashes, dry and leached, and farm manures, were likewise employed, as indicated below. A number of brands of manufactured fertilizers were also tried, with results according with those from the regular experimental fertilizers.

The soil Mr. Bartholomew describes as "hill land, dark loam, moist, with clayey subsoil. The land of this experiment was in 1874 an old meadow, yielding about one ton of hay per acre. In 1875 it was plowed, dressed with twelve cart-loads per acre of yard manure, planted to corn, and gave 35 bushels per acre. In 1876 it was sowed to oats, with no additional manure; yield, 40 bushels." In 1877 experiments began with corn. The land has thus been out of grass for five years—one with oats and four with corn. The seasons of 1877 and 1878 were on the whole favorable. In 1879 "the spring was late, there were some storms in July and August which beat the corn nearly flat, and stripped the leaves into shreds. At harvest the stalks below the ears were inclined to the south at an angle of about 45 degrees. Frost killed the corn September 25th, before the corn matured." The produce per acre during the three years has been as follows:

	FERTILIZER.		Yield of shelled corn per acre in bushels.		
Plot.	Kind.	Amt. per acre.	1877.	1878.	1879.
1	Dried Blood,	320 lbs.,	13.7	10.0	—*
2	Superphosphate	320 lbs.,	41.6	39.8	21.7
3	Muriate of potash,	320 lbs.,	15.5	11.0	—*
4	Mixture I+II,	160 lbs. of each,	38.0	35.4	22.4
5	Mixture I+II+III,	106⅔ lbs. of each,	33.5	30.5	20.7
6	Plaster,	320 lbs.,	19.4	11.0	—*
0	No manure,		6.2	3.0	—*
7	Wood ashes, dry,	32 bushels,	34.9	30.4	—*
8	Wood ashes, leached,	48 bushels,	37.7	36.6	†24.6
9	Hog manure,	16 cart-loads,	41.1	46.6	
10	Hen manure,	20 bushels,	54.9	56.7	

In the report of Mr. Bartholomew's experiments for 1877, it was noted that "(1) In the four cases, Nos. 1, 3, 6, and 0, where phosphoric acid was not supplied, the crop failed. (2) In every case where phosphoric acid was supplied, either alone (*i. e.*, as superphosphate with the lime and sulphuric acid incident thereto), in No. 2, or with other materials in Nos. 2, 4, 5, 8, 9, and 10, the crop was good. (3) The amounts of phosphoric acid per acre in Nos. 2, 4, and 5 were 51, 25½, and 17 lbs., respectively; the yields, 41.6, 38, and 33.5 bushels, show a corresponding decrease. Comparisons of the amounts of phosphoric acid applied and corn produced in the other cases, of which limited space excludes details, show a similar and singularly uniform ratio between the two. This parallelism between phosphoric acid and yield runs through the plots with ashes which contained less of the phosphoric acid, and brought less corn; and those with farm manures, which contained more, and brought more. (4) The produce with potash-salt, and with dried blood alone, was less than on the one plot with no manure. (5) While the crop responded uniformly to the phosphoric acid, it got little apparent benefit from the other ingredients of either the chemical fertilizers, the ashes, or the farm manure. (6) As indicated by the money costs of fertilizers applied, and corn produced, there was uniformly a gain of from $10 to $12.50 per acre from phosphoric acid alone or with a little nitrogen, a smaller gain in each case where phosphoric acid was supplied with other substances, and, in every case where it was omitted, a loss. What the soil needs most, at least to produce corn, is clearly phosphoric acid."

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* Entire failure.

† In 1879, 16 cart-loads well-rotted stable manure, instead of ashes.

The results for 1878 were almost identical with those of 1879. In 1879 late frosts in spring, severe storms in summer, and early frost in September injured the crop. Mr. Bartholomew says, "The yields marked by the dash [the ones which got no phosphoric acid, see table,] were so poor that neither fodder nor grain were of much account. . . . . This field, in consequence of five successive years' plowing and planting, is not in good condition for corn. 1st. It has become too weedy. The wet season has been favorable to the weeds, which have increased yearly, although the corn was well hoed twice. After the severe storm in August the corn was lying so near the ground that it was impracticable to destroy the weeds without injuring the corn, and . . . . they were so large as to retard the growth of the corn. 2d. The soil has become very mellow, [the roots left by the grass have been also consumed,] and it is in such condition as seems ill adapted to corn. The corn on this piece has at no time been in as good condition as that on the sward land adjoining, although both were planted the same day, with seed from the same lot, by the same persons." After further comparisons between this and the other experiments, Mr. Bartholomew adds, "But under any circumstances I think corn will not do as well on ground which has been under cultivation several successive years as on inverted sward. Other things being equal, I expect my best corn on land which has been in grass the previous year."

In brief, in this three years' experiment, the yield of corn without phosphoric acid has in every case run down to nearly nothing. In every case with phosphoric acid it has kept up fairly well until this last season, when the corn has suffered much worse from bad weather than that with similar fertilizers on new land. Thus the yield with a good dressing of stable manure in 1879, on the plots which in 1877 and 1878 had ashes and gave good yields, amounted in 1879 to only 24.6 bushels against 36 bushels with similar manuring close by in corn experiment No. 2 (see table V, beyond).

Mr. Bartholomew has made four other experiments which are reported in tables I, II, IV, V, and VI, but which the space at my disposal forbids my describing in the detail they deserve. There are, however, a few points which it would be wrong to omit. Besides the trials which appear in the tables, Mr. Bartholomew has made a large number of others, duplicating the same fertilizers several times in single experiments. One noticeable thing is the uniformity of the duplicates. In 1877 and 1878, with 300–320 lbs. of superphosphate the yield of corn rarely varied more than 1½ bushels from 40 bushels per acre. In 1879, however, the yields in eighteen duplicates on new land ("see special corn experiments") were somewhat less, ranging generally from 35½ to 39 bushels, while that in the experiment above on land that had been cropped with corn several years, is only about 22 bushels.

FAVORABLE RESULTS WITH FARM MANURES AND SUPERPHOSPHATE TOGETHER.

Another interesting fact has been Mr. Bartholomew's success with farm manures and superphosphate together. In his special corn experiment of 1878, hog manure and superphosphate, each by itself, gave respectively 36 and 36.5 bushels per acre. A contiguous plot with the same amount of hog manure plus 200 lbs. superphosphate gave 53.7 bushels per acre. In the other experiments kindred results have been observed. The experience has been confirmed on a large scale the past season. Mr. Bartholomew writes, "On a field of 2½ acres [adjoining the one where the experiments were made] I had a remarkably good field of corn. It was manured in the hill with a mixture of old yard manure, stable dung, and dissolved boneblack, the last at the rate of 200 lbs. per acre, a dressing of green yard manure having been also spread and harrowed into the surface. A part of this, without the bone-black, gave some 48 bushels per acre. That with the addition of the 200 lbs. of superphosphate gave, in despite of the bad season, some 75 or 80 bushels of as fine ripe corn as I ever saw. I think the best way for me to get corn is to use superphosphate with yard manure."

MR. SAGE'S EXPERIMENTS.

Mr. C. Sage of Middletown, Conn., has likewise been experimenting for three years, but has not repeated the trials on the same plots. His experience in three different fields in his farm is about the same. Potash salts bring excellent results with all crops in every experiment, the increase repaying the cost from three to fifteenfold. Generally the complete fertilizer has been profitable also. Some less extensive experiments with potatoes tell equally favorably stories for both the potash salts and the complete fertilizers. Muriate of potash and fine ground bone gave the past season a much larger yield than farm manure, and the potatoes were of larger size and of much finer quality. Mr. Sage has had no less gratifying success with potash salt and bone dust on wheat and oats. He even goes so far as to say that the artificial fertilizers that bring him so much better crops than his farm manures cost less, freight and applying included, than the mere hauling of the manure to some of the fields of his farm.

I much regret that lack of space forbids discussion in detail of the other experiments of Tables I–IV, some of which, like those of Dr. Cutting of Vermont, and Mr. Hicks of Long Island, and doubtless others with which I have had less opportunity to become familiar, are very instructive. In brief,—

1. Such experiments cannot have their full value until they have been carried through a series of years with the same fertilizers on the same plots. It is not until such repeated cropping has removed the accumulated stores of plant food of the soil that the power of the soil to keep up a permanent supply of food, and of the plant to gather it from soil and air are revealed.
2. For the farmer's purpose, that of finding what fertilizers are most helpful for him, continuation of the experiments is needed both to learn what the soil can do on the long run and how different crops are affected by the same fertilizers.
3. Nevertheless, in nearly all the cases where the experiments were begun on worn-out soils, the repetitions have accorded very closely with the first results.
4. These experiments, rightly made, do bring the information which the makers have been most interested to get.

EFFECTS OF DIFFERENT FERTILIZERS ON THE QUALITY OF THE CROPS.

The effects of the different fertilizers on the proportion of good to poor corn, and of corn to stalks, are worth noting before we close.* A number of experimenters reported the amounts of "good" and "poor" corn; but fourteen, however, had made thoroughly accurate weighings. The percentage of "good" corn, i. e., the number of pounds in 100 lbs. total corn, were:

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*It is of course understood that these figures are not absolutely accurate. See "*Details of the Experiments*," in special "extra" copies of this report.

NUMBER OF POUNDS OF "GOOD" CORN IN 100 POUNDS OF TOTAL CORN, WITH THE DIFFERENT FERTILIZERS.

NUMBER OF EXPERIMENT.	O	A.	B.	C.	D.	E.	F.	G.	H.	
	Nothing.	Nitrogen.	Phosphoric Acid.	Potash.	Nitrogen and Phosphoric Acid.	Nitrogen and Potash.	Phosphoric Acid and Potash.	Nitrogen, Phosphoric Acid, and Potash.	Gypsum.	Farm Manures.
4	48	46	56	58	69	63	82	86	67	64
5	94	91	92	83	95	92	85	92	62	..
7	28	89	78	72	77	95	85	83	77	59
8	22	26	39	67	44	27	24	21	8	56
11	61	56	68	48	83	52	62	84	48	58
12	89	81	58	84	61	53	49	16	26	..
14	84	74	91	78	76	67	80	84	..	71
15	19	23	30	23	28	26	29	33	37	41
17	68	68	88	51	86	60	80	84	68	..
18	72	57	86	52	82	48	74	45	78	..
22	81	87	94	95	94	96	96	95	95	..
20	68	65	85	64	..	..	..	88	89	..
24	86	87	90	92	90	94	93	97	94	..
26	68	67	71	67	69	61	67	77	67	..
Average of 14 Experiments in 1879,	56	58	72	62	73	64	61	69	63	58
Average of 8 Experiments in 1878,	65	67	72	80	72	86	86	85	73	81

The figures accord with common experience that the largest crop has the largest proportion of good corn. I see nothing to account for the poorer average quality in 1879, except the bad season.

RATIO OF STALKS TO SHELLED CORN.

The weighings of corn and stalks were made at different stages of dryness. In some cases the stalks were cut above the ears, in others close to the ground. The results are consequently discrepant. The averages are interesting as showing the relative effects of the fertilizing materials. The figures represent the number of pounds of stalks to 100 pounds of shelled corn in 12 experiments.

NUMBER OF POUNDS OF STALKS TO 100 POUNDS OF SHELLED CORN.

	O	A.	B.	C.	D.	E.	F.	G.	H.	
NUMBER OF EXPERIMENT.	Nothing.	Nitrogen.	Phosphoric Acid.	Potash.	Nitrogen and Phosphoric Acid.	Nitrogen and Potash.	Phosphoric Acid and Potash.	Nitrogen, Phosphoric Acid, and Potash.	Plaster.	Farm Manure.
3	374	625	262	487	383	491	320	375	487	...
4	124	94	107	104	70	109	138	89	117	152
5	100	118	205	335	122	166	307	195	429	...
6	281	190	164	154	187	182	136	70	271	66
8	304	228	156	174	145	226	155	144	422	131
11	108	281	140	321	86	272	192	139	98	128
14	146	134	91	110	110	139	175	152	...	157
15	72	95	75	75	85	98	89	97	95	88
17	184	186	185	218	140	216	155	165	186	...
22	98	92	90	104	95	97	98	89	96	108
21	...	66	96	79	72	74	69	72	77	75
25	158	104	163	191	110	254	141	151	188	140
Average of 12 Experiments in 1879..................	149	156	120	168	105	162	141	124	219	115
Average of 10 Experiments in 1878,................	173	143	149	145	129	176	128	131	139	133

The proportion of stalks to shelled corn is smaller in the larger crops, and conversely the poorer crops have more stalks for the same amount of corn than the better crops. Contrary to what is commonly supposed, the nitrogenous fertilizing materials do not seem to have increased the amount of stalks as compared with shelled corn. As to

THE EFFECTS OF THE FERTILIZERS ON QUALITY OF OTHER CROPS,

There are but few reports. Several have spoken of the quality of the potatoes grown with chemicals as compared with farm manures. The unanimous testimony is that the potatoes with artificial fertilizers were of finer quality, and less disposed to rot than with the farm manures.

THE FEEDING CAPACITIES OF PLANTS.

A vast deal of experience in the laboratory and in the field bears concurrent testimony to the fact, though we are still deplorably in the dark as to how or why it is so that different kinds of plants have different capacities for making use of the stores of food that soil and air contain.

Leguminous crops, like clover, do somehow or other, gather a good supply of nitrogen where cereals, such as wheat, barley, rye, and oats, would half starve for lack of it, and this in the face of the fact that leguminous plants contain a great deal of nitrogen, and cereals relatively little. Hence a heavy nitrogeneous manuring may pay well for wheat and be in large part lost on clover.

As long ago as 1850, Dr. Pusey said in a report "*On the Progress of Agricultural Knowledge during the last Eight Years*" in the Journal of the Royal Agricultural Society (vol. xi, 1850, pp. 385–6), "At present we can only say that the three leading principles of manure are, 1. AMMONIA; 2. PHOSPHORUS; and probably 3. CARBON;" and again, "The upshot of the whole is that practically, as far as artificial manures are concerned, we need not dwell upon the mineral ingredients, but must give ammonia to wheat, and to turnips phosphorus." Since Dr. Pusey's time we have got hold of very many new facts, theories of manuring have multiplied, and fertilizers for special crops made according to various formulas have come into common use.

THE VILLE FORMULAS AND SYSTEM OF MANURING.

Of the numerous formulas for fertilizers for special crops, no others have attracted so much attention as those of Prof. George Ville of Paris, whose experiments at the Government Farm at Vincennes during 25 years or more, have been discussed, and whose writings are read the world over. These formulas form a part of a "system of manuring" which may be briefly explained as follows:

According to Ville, of the dozen or more constituents of dung, FOUR—nitrogen, phosphate of lime (phosphoric acid), potash, and lime, which constitute about one-tenth of its weight—are "the regulators *par excellence* of production, and the only ones with which agricultural industry need occupy itself." His formulas for "complete manures" supply these four ingredients—the *nitrogen* as nitrate of potash (saltpeter), nitrate of soda, or sulphate of ammonia; the *phosphoric acid* in the form of superphosphate; the *potash*, in either nitrate of potash, or other potash salts, and the *lime* as sulphate of lime (land plaster). He says that "the mixture of these substances has the same properties as dung." The "complete chemical manure is to the barnyard manure what the metal is to the ore." "It is farm-yard manure divested of all useless matter."

The formulas which are made for different crops are based not merely upon the compositoin of the plant, but also upon its assumed capacity for getting its food from air and soil, and the effect of the different materials upon its growth. "Each of the four regulating ingredients has its own functions, which are of more or less relative importance according to the nature of the plant to which it is applied. . . . ." No one can do any good without the coöperation of the other three (though if either is supplied in abundance by the soil it need not be included in the manure). Give the others, and each has its own predominant action for a certain list of crops.

"DOMINANT INGREDIENTS."

Ville gives "the name *dominant* to the ingredient which, for a given crop, plays a more important part than the others." Thus:

"*Nitrogen* is the predominant ingredient for the cereals, as Wheat, Barley, Rye, Oats, and for Colza, Sugar-beet, Hemp, etc."

"*Potash* has an especial influence upon Peas, Beans, Clover, Lucern, Flax, Potatoes, etc."

"*Phosphoric acid* is especially beneficial for Turnips, Rutabagas, Radishes, Indian Corn, Sugar cane, etc."

"*Lime* seems to exert no especial preponderating action upon any plant, but is necessary for all."

The practical inference is that in preparing a fertilizer for a given plant, we must reduce the subordinate ingredients as much as we can, and put in a good deal of the dominant. To sustain his propositions, Ville cites a great many experiments, some made by himself in pots or in the fields of the Experimental farm at Vincennes, and others by farmers in France and elsewhere. In an experiment on wheat, for instance, one plot received a "complete manure;" from another the lime (sulphate of lime) was omitted, while the third had no potash, etc.

Fertilizer.	*Yield of Wheat per Acre.*	
Nothing	15.88	bushels.
"Complete Manure,"	56.44	"
"Complete Manure," without Lime,	58.33	"
"Complete Manure," without Potash,	40.44	"
"Complete Mannre," without Phos. Acid,	34.66	"
"Complete Manure," without Nitrogen,	18.18	"

The wheat suffered more from lack of nitrogen than from lack of any other ingredient. Again, with sugar-beets, starting with a complete fertilizer which supplied 360 lbs. of superphosphate, 180 lbs. of nitrate of potash, 270 lbs. of nitrate of soda, and 360 lbs. of sulphate of lime per acre, when more lime, potash, or phosphoric acid was added, the yield was not affected, but when the nitrogen was increased, the yield rose with it. From such experiments as these, Ville infers that nitrogen is the dominant ingredient for wheat and the sugar beet, and consequently he puts a large proportion of it in his formulas for these crops. He insists, furthermore, that the form of combination is important, and uses sulphate of ammonia for wheat, nitrate of soda for sugar-beets, and so on. For clover, beans, peas, etc., he recommends little or no nitrogen, because the plants are found to get very little if any good from nitrogenous manures. He explains this by assuming that such plants get all their nitrogen from the air, and do not need it in fertilizers. Of the theory once held by many, that plants assimilate the free nitrogen of the air, Ville has been for some years almost the only prominent defender. He claims that clover gathers all its nitrogen from the air; that barley and rye get 80 per cent., wheat, 50 per cent., and sugar beet, 60 per cent. from the air, and the rest from the soil. But by far the most valuable contribution to our knowledge of these subjects comes from the classic

EXPERIMENTS BY MESSRS. LAWES AND GILBERT, IN ENGLAND.

In their experiments, wheat, which has for thirty years received mineral manures alone, has averaged 16¾ bushels per acre yearly, against 14 bushels unmanured. The addition of sulphate of ammonia, with the same repeated cropping of the same land, brought the average up to 36 bushels per acre. The leguminous crops have told just the opposite story. Though they contain a good deal more nitrogen than wheat, they respond but slightly to nitrogen, and are greatly aided by mineral manures. In an experiment on the mixed herbage of grass land, continued through twenty years, mineral manures without potash brought up the total crop 47 per cent., and the nitrogen in the crop 38 lbs. per acre annually above the unmanured. And when potash was added to the mineral manures, the crop was 67 per cent. larger and contained 56 lbs. more nitrogen per acre than the unmanured.

In one case Messrs. Lawes and Gilbert found that a soil from which a clover crop had just been removed contained more nitrogen than it did before the clover was put in; that, in other words, the soil, to the depth of nine inches at least, was positively enriched by the growth and removal of a highly nitrogenous (clover) crop.

Such facts help to explain why it is such good farm practice to use mineral fertilizers, as plaster, bone, ashes, and potash salts, for mixed grasses and clover; and nitrogenous materials, like guano, sulphate of ammonia, and nitrate of soda, for grain crops. They help us to understand why clover is such an excellent preparatory crop for wheat, and so economical generally for plowing under to bring up poor soils. It gathers and stores plant-food, particularly nitrogen, and thus is itself a fertilizer.

In Messrs. Lawes and Gilbert's experiments, the cereals have been most helped by nitrogen, next by phosphates, and very little by potash; the legumes have responded to mineral manures, especially potash, and paid little heed to nitrogen except where on meadow land they have, under the influence of nitrogenous manuring, gradually run out, and the grasses have taken their place, just as they have replaced the grasses when mineral manures alone were used; turnips have done best with superphosphates; and potatoes, I think, have seemed to demand potash along with nitrogen and phosphates for their best development.

THE FEEDING CAPACITY OF MAIZE.

Of the feeding capacity of our great staple, corn, and the effect of different fertilizers upon its growth, but little is known.

The main question is the nitrogen supply—whether, like other cereals (wheat, barley, oats, grasses, etc.), corn has but little power to get nitrogen from natural sources, and requires nitrogenous fertilizers, or, whether, like leguminous plants (clover, beans, peas, etc.), corn can gather the nitrogen for itself; that is, whether corn is, like wheat, an exhausting crop, or like clover, a renovating crop. Mr. Harris, in his book on manures, is rather inclined to class it with the cereals, but mentions some facts which indicate that in feeding capacity it is more like the leguminous plants. If the latter is the case, then Indian corn grown and consumed on the farm, will, "like clover, enrich the land, . . . the corn will gather up the nitrogen that the wheat crop cannot appropriate, and when the corn and stalks are fed, some 90 per cent. of the nitrogen will be left in the manure."

Mr. Lawes has written a letter to the Secretary of the New Jersey Board of Agriculture, and also another letter to Mr. Harris, discussing this same question, and insisting, as Mr. Harris also does, upon the need of experiments to test it. He says, "It is of very great importance to know to what extent Indian corn follows the same law [as the cereals]; that is to say, on a soil which, under a liberal supply of potash and phosphoric acid, will yield 20, 30, or 40 bushels of corn, what increase is obtained by a liberal supply of ammonia or nitrates?" Mr. Lawes is inclined to class corn with the cereals, though he would expect that with mineral fertilizers it would, during its longer period of growth, get more food from soil and air, and especially, more nitrogen, and give a larger produce than wheat.

Special Experiments upon the Effects of Nitrogenous Fertilizers upon Corn and Potatoes.

To get more light upon this question, a special experiment was devised last year, and carried out by several gentlemen with corn. Similar ones were repeated this year on corn and potatoes. The following, from the notes sent to the experimenters, will explain the plan:

SPECIAL EXPERIMENTS FOR NITROGEN TESTS, 1879.

Object.

"The object of this experiment is to test the effects of nitrogenous fertilizers in different amounts and combinations upon the growth of the crop, and inferentially the capacity of the plant to gather its nitrogen from natural sources.

The Fertilizers,—Amounts and Ingredients.

"The materials and amounts are such as are used in ordinary practice. The amounts of phosphoric acid and potash are about as would occur in a corn crop of 50 or 60 bushels; the nitrogen is supplied in ⅓, ⅔. and full amount in same crop.

Quantities of Nitrogen.

"The nitrogen is applied at the rate of

24 lbs. per acre:	'⅓ Ration,'
48 " " "	'⅔ Ration,'
72 " " "	'1 Ration,'

Forms of Nitrogen.

"The nitrogen is supplied as

1. Nitric Acid, in Nitrate of Soda.
2. Ammonia, in Sulphate of Ammonia.
3. Organic Nitrogen, in Dried Blood.
4. A Mixture of the above, in Nitrogen Mixture.
5. Ammonia, Urates, etc., in Peruvian Guano.

Arrangements of Fertilizers and Plots.

"The ingredients are supplied in:

Partial fertilizers,	Group 1.	Each by itself.	Thus testing the effects of ingredients separately, and capacity of soil.
	Group 2.	Two by two.	
Complete fertilizers.	Group 3.	Nitrogen as Nitrate of Soda.	Nitrogen in different proportions, $\frac{1}{3}$, $\frac{2}{3}$, and full ration.
	Group 4.	'Nitrogen in Nitrogen Mixture.'	
	Group 5.	Nitrogen in Sulphate of Ammonia. Dried Blood and Peruvian Guano.	Nitrogen, $\frac{2}{3}$ ration in different combinations.

"The above make 15 kinds of fertilizers in 15 bags, numbered Nos. I–XV. No. VI, "Mixed minerals," superphosphate and potash salt is repeated as No. XVI. The object of duplicating this and those with the varying quantities of nitrogen, is to test the uniformity of the soil, and the accuracy of the experiment.

"The amounts and composition of the fertilizers are shown on the accompanying sheet (see Table V).

"Sets of two sizes are furnished. 'Full size,' for $\frac{1}{10}$ acre plots, the experiment to cover two acres, and 'half size,' for $\frac{1}{20}$ acre plots, the whole to cover one acre. The materials are the same in both. It will be well to use stable manure, ashes, and other fertilizers along with the regular set."

Two sets were placed by the University of Vermont and State Agricultural College in the hands of Col. J. B. Mead, Superintendent of agricultural affairs in that State, who used one for an experiment with corn herewith reported, and the other for an experiment on permanent grass land, whose results may be looked for hereafter. Two were purchased by the Maine State College of Agriculture and the Mechanic Arts, one for a repetition of the same experiment in 1878, and one to be used by a prominent farmer of that State; unfortunately frost prevented the maturing of the crop in both cases. Two sets were used by Mr. W. J. Bartholomew of Putnam, Conn., and one by Mr. C. Sage of Middletown, Conn., with results as reported herewith. Another was used by Mr. J. M. Hubbard of Middletown, Conn., in an experiment with potatoes which was vitiated by rot.

The fertilizers were very carefully prepared by the Mapes Formula and Peruvian Guano Company of New York, through whose interest in the matter one set was supplied gratuitously, and the rest at less than cost.

The results appear in tables V and VI, in which are given those of the experiments of 1878 for comparison.*

RECAPITULATION OF EFFECTS OF NITROGENOUS FERTILIZERS UPON CORN.

As regards the effects of nitrogen in different forms, in 1878, the Peruvian guano brought the largest increase; the mixture of nitrate of soda, sulphate of ammonia, and dried blood next; then followed, in order of valuable effects produced, nitrate of soda, sulphate of ammonia, and last and worst of all, dried blood.

In 1879, with the irregularities in experiment C, and the positively injurious action of the nitrogen in D, the order of efficiency of the ingredients is altered so that in the average for the two years the sulphate of ammonia comes first, the Peruvian guano second, and the nitrate of soda last. But more trials are necessary to give reliable information as to the action of the materials. Here, as elsewhere, the factors of the problem are so multiplex that much research will be needed to disentangle and measure them.

Estimating a bushel of corn, with its cobs and stalks, to contain 1⅓ lbs. nitrogen, and to be worth 80 cents, the effects of the nitrogenous fertilizers in all the experiments, general and special, may be summarized as follows, remembering that the superphosphate and potash salt, "mixed minerals," supplied the amounts of phosphoric acid and potash in a crop of not far from 50–60 bushels, which would also contain about 72 lbs. of nitrogen:

AVERAGE RESULTS OF EXPERIMENTS OF 1878 AND 1879.	THE CROPS AVERAGED BUSHELS PER ACRE.			THE CROPS CONTAINED NITROGEN PER ACRE.		
Special Experiments.	1878. 3 exp'ts.	1879. 3 exp'ts.	1878 and 1879. 6 exp'ts.	1878. 3 exp'ts.	1879. 3 exp'ts.	1878 and 1879. 6 exp'ts.
Mixed minerals alone,	50.8	50.6	50.7	67.7	67.5	67.6
" " + 24 lbs. Nitrogen,	57.7	51.8	54.8	76.9	68.0	73.0
" " + 48 lbs. Nitrogen,	58.4	52.5	55.5	77.9	70.0	74.0
" " + 72 lbs. Nitrogen,	60.0	50.9	55.5	80.0	67.8	73.9
General Experiments.	27 exp'ts.	26 exp'ts.	52 exp'ts.	27 exp'ts.	26 exp'ts.	53 expt's.
Mixed minerals alone,	42.9	40.8	41.9	57.2	54.4	55.8
" " + 24 lbs. Nitrogen,	48.6	46.7	47.7	64.8	62.3	63.5

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* In 1878, three plots had nitrogen alone one nitrate of soda, another sulphate of of ammonia, and the third dried blood. The effects of nitrogen alone, proved so unsatisfactory that in 1879, a single one, with a mixture of all three was substituted. Accordingly in tabulating the experiments of 1878, the average of these three is given as No. 1.

RECAPITULAT ON CORN AND

INC LONE.

"Mixed minerals"—300 ash. "Nitrogen Mixture"—
Nitrogen of Soda, Sulphate o be worth 80 cents.

		Mixed Minerals.
Experiment A, 1878	....	70.3
" B, 1878	....	63.4
" B, 1879	....	48.1
" B, 1879	....	50.5

AL RESULT.

NITROGEN COMP TO "MIXED MINER		n +, or loss —, from use of Nitrogen.		
		verage of Corn Experiments.		Potato.
		3 in 1879.	6 in 1878-9.	1 in 1879.
No. 7.—Nitrate of Soda, 150	4	$—6.56	$—3.01	$3.38
No. 8.— " " 300	7	—10.53	—8.45	2.55
No. 9.— " " 450	0	—18.07	—14.03	7.87
No. 10.—Nitr'n mixture, 150	5	—2.05	—1.25	22.35
No. 11.— " " 300	4	—11.62	—7.28	2.70
No. 12.— " " 450	3	—14.15	—10.99	—0.15
No. 13.—Sul. of Ammo., 225	0	—3.16	—3.48	9.08
No. 14.—Dried Blood, 450	2	—6.28	—5.96	10.28
No. 15.—Peruv. Guano + M	9	—5.65	—4.37	—5.89

* Of Numbers 7 to 9 as c verage of 6 and 16.

That is to say, in both seasons' experiments, the corn supplied with phosphoric acid, sulphuric acid and lime by the superphosphate, and potash by the muriate, gave respectable yields and gathered considerable nitrogen from soil and air. In the special experiments, with average weather, on fair corn lands, the yield per acre ranged from 39.3 .to 70.3 bushels, averaging 50.7 bushels, with 67.7 pounds of nitrogen; while, in the fifty-three experiments in all sorts of weather, and on soils good, bad, and indifferent, but mostly very poor, and many not fitted for corn, the average yield was 41.9 bushels with 55.8 pounds of nitrogen.* Nor was the crop much increased by the addition of nitrogen as nitric acid in nitrate of soda, as ammonia in sulphate of ammonia, as organic nitrogen in dried blood, in a mixture of all these three, or in the Peruvian guano.

The experiments of the two seasons bear unanimous testimony to two things. The corn was helped but little by nitrogenous fertilizers, and it gathered a good deal from natural sources. The increase of crop and of nitrogen in the crop will appear more clearly if we look at it another way.

	In number of trials.	With Nitrogen.		The average increase of Corn was	The increase of Nitrogen in the crop was
		Amount per acre.	Contained in Crop of		
1877-8	29	24 lbs.	18 bushels.	5.9 bushels.	7.9 lbs.
	15	48 "	36 "	7.6 "	9.1 "
	6	72 "	54 "	9.3 "	12.4 "
1879	26	24 lbs.	18 bushels.	5.9 bushels.	7.9 lbs.
	14	48 "	36 "	1.9 "	2.5 "
	6	72 "	54 "	0.3 "	0.4 "
1878 and 1879	55	24 lbs.	18 bushels.	5.9 bushels.	7.9 lbs.
	29	48 "	36 "	4.8 "	5.8 "
	12	72 "	54 "	4.8 "	6.4 "

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* Of the seven special experiments, five were on land fairly well adapted to corn, two—those in Maine—being on a wet, heavy clay, and in a cold climate. In one of these latter, that of 1879, the corn failed to mature on account of frost early in September, but it doubtless gathered about as much nitrogen as if it had matured. Allowing this to have the same yield and amount of nitrogen as last year, the average yield of the seven experiments would be 49 bushels, with 65.3 lbs. of nitrogen. It is hardly fair, however, to include a trial under such unfavorable circumstances, in making an estimate of results to be expected on soils and in latitudes favorable for corn. If the "special corn experiments," in conditions proper for this crop, are to be accepted as a criterion, it would seem fair to expect, in average seasons, on soils and in latitudes adapted to corn, an average yield of 50 bushels, with 67 lbs. of nitrogen.

Or, from the pecuniary standpoint:

	In Trials. Total number.	With Nitrogen. Amounts.	Costing.	The Nitrogen paid for itself in trials.	The Nitrogen failed to pay for itself in trials.	The average loss in the several trials was
1878	29	24 lbs.	$5.62½	8	21	$0.90
	15	48 "	11.00	1	14	4.45
	6	72 "	16 50	none.	6	8.51
1879	26	24 lbs.	$5.62½	5	21	$0.90
	14	48 "	11.00	1	13	9.48
	6	72 "	16.50	none.	6	16.26
1878 and 1879	55	24 lbs.	$5.62½	13	42	$0.90
	29	48 "	11.00	2	27	7.47
	12	72 "	16.50	none.	12	12.39

The nitrogen increased the crop enough to pay the cost in thirteen trials out of ninety-six. The pecuniary loss rose and fell with the amount of nitrogen used. With mineral fertilizers alone the crop gathered by the above estimates some 65 lbs. of nitrogen per acre.*

THE DOMINANT FERTILIZING INGREDIENT FOR CORN.

According to Ville the "dominant" for corn is phosphoric acid. The effects of the superphosphate potash salt and nitrate of soda in the experiments may be stated as follows:

1. *Effect of Phosphoric Acid, i. e., of Superphosphate.*—In 8 experiments, Nos. 2, 3, 7, 11, 14, 17, 18, and 26, phosphoric acid was decidedly the regulating ingredient, the crop responding uniformly to it, and paying comparatively little attention to the others.

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*Since the above went to the printer, I have been favored with reports of experiments of a similar character upon the farm of the New Hampshire Agricultural College, by Mr. J. W. Sanborn, farm superintendent. A mixture of 186 lbs. superphosphate and 128 lbs. muriate of potash, gave in 1878, 37 bushels, and in 1879, with the same materials, on the same plots, 67.4 bushels of shelled corn. On other plots nitrogen, in the form of sulphate of ammonia, was added in successive quantities of 80, 160, 240, and 320 lbs., furnishing 16, 24, 48, and 64 lbs. of nitrogen. In 1878 the corn rose with the nitrogen, giving with the largest amount, 69 bushels per acre against 37 bushels without nitrogen. But in 1879 the results with the same materials on the same plots were just the reverse. While the yield with the mixture of superphosphate and potash salt was 67.4 bushels against 37 in 1878, the plot with the smallest amount of nitrogen gave 69 bushels, and those with more nitrogen less and less, the yield with the 64 lbs. of nitrogen falling down to 45.8 bushels. Mr. Sanborn says: "Last year, in round numbers, $12.00-worth of ammonia salts [240 lbs.] paid a profit for use. This year they are worse than useless. . . . I can only say that I believe the character of the season has more to do with the power of the plant to gather its nitrogen from natural sources than has been generally recognized." It is noticeable that the experiments of Mr. Sanborn and Col. Mead, in which nitrogen decreased the crop, were both in the same region and not many miles apart.

In 13 experiments, Nos. 4, 5, 6, 8, 9, 10, 13, 15, 20, 21, 22, 23, and 25, the superphosphate, though not holding relatively so important a place, was more or less useful. In 5 experiments, Nos. 1, 12, 16, 19, and 24, the superphosphate produced little or no effect, the average increase of the several plots of each experiment being less than 4 bushels per acre.

2. Effect of Potash, i. e., of Muriate of Potash.—In 5 experiments, Nos. 6, 10, 15, 22, and 24, potash was decidedly the regulating ingredient, the crops responding uniformly to it, and paying comparatively little attention to the others. In 6 experiments, Nos. 7, 9, 12, 14, 21, and 23, the potash salt, though not holding so important a place, was more or less useful. In 15 experiments, Nos. 2, 3, 4, 5, 8, 1, 11, 13, 16, 17, 18, 19, 20, 25, and 26, the potash salt produced little or no effect, the average increase of the several plots of each experiment being less than 4 bushels per acre.

3. Effect of Nitrogen, i. e., of Nitrate of Soda.—In 1 experiment, No. 4, nitrogen was the regulating ingredient. In 11 experiments, Nos. 5, 6, 9, 11, 12, 13, 14, 21, 22, 25, and 26, nitrogen, though not holding a very important place, was more or less useful. In 14 experiments, Nos. 1, 2, 3, 7, 8, 10, 15, 16, 17, 18, 19, 20, 23, and 24, nitrogen produced little or no effect, the average increase of the several plots of each experiment being less than 4 bushels per acre.

The outcome of the trials of 1877 and 1878 in these respects may be tabulated as below:

Effects of the Fertilizing Materials.	Superphosphate.				Muriate of Potash.				Nitrate of Soda.			
	Regulating Ingredient.	More or less efficient.	Inefficient.	Total.	Regulating Ingredient.	More or less efficient.	Inefficient.	Total.	Regulating Ingredient.	More or less efficient.	Inefficient.	Total.
In 27 Experiments of 1878,.........	8	13	6	27	4	13	10	27	..	16	11	27
In 26 Experiments of 1879,.........	8	13	5	26	5	16	15	36	1	11	14	26
In 53 Experiments of 1878 and 1879,.	16	26	11	53	9	19	25	53	1	27	24	53

Phosphoric acid took the leading place often, potash occasionally, and nitrogen almost never. In bad seasons, and on some soils in good seasons, neither material had any effect. The most effective ingredient depended upon soil and season.

IS CORN IN ITS RELATIONS TO NITROGEN MORE CLOSELY ALLIED TO THE CEREALS OR THE LEGUMES?

Our experiments imply that corn shares, to a considerable extent, the power of the legumes for gathering nitrogen from natural sources. One thing, however, detracts from their decisiveness. Most of the trials were on old grass land which contained large quantities of roots on which the corn doubtless fed. How well it could provide itself with nitrogen from nitrogen compounds in the soil and from air without the roots to feed upon is not settled.

The experiments are numerous and decisive enough to warrant the inference that, as corn is commonly grown, nitrogenous fertilizers in any considerable quantity would be rarely profitable. They imply but do not prove that corn has somehow or other the power to gather a great deal of nitrogen from soil or air or both, they imply that in this respect it comes closer to the legumes than the cereals, —that, in short, corn may be classed with the renovating crops.

THE FEEDING CAPACITIES OF POTATOES, TURNIPS, AND OTHER CROPS.

How much light our experiments throw upon the habits of other crops in this respect may best be seen from a single comparative experiment with corn and potatoes by Mr. Bartholomew, in Table V and VI, and from a comparative summary of the average results of all the experiments in Table VII.

But one "special nitrogen experiment" with potatoes was made; that of Mr. Bartholomew, "B 1879" in Tables V and VI. In that, corn and potatoes were planted side by side.* Each of the sixteen fertilizers was spread over a strip of one-tenth acre, making sixteen

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* Mr. Bartholomew has hit upon what seems to me an excellent arrangement of plots for a comparative experiment of this sort with different crops. The problem was to try corn and potatoes side by side and at the same time test the uniformity of the soil. The experiment included sixteen different fertilizing materials on as many plots. Mr. Bartholomew accordingly laid out sixteen parallel plots of one-tenth acre each, on which the fertilizers were applied; between each two of these he left a strip of one-half the width, one-twentieth acre, on which superphosphate was put. These intervening superphosphate plots were planted with corn and served the double purpose of separating the other plots and testing the uniformity of the soil. The yields were quite uniform. The other plots, each one-tenth acre, which received the experimental fertilizers were divided lengthwise into one-twentieth acre strips. On one strip corn and on the other potatoes were planted. For convenience in cultivating, the hills of potatoes were left the same distance apart as the corn, which reduced the size of the potato crop very materially,—Mr. Bartholomew thinks nearly one-half.

TABLE VII.

AVERAGES OF RESULTS OF EXPERIMENTS OF 1878 AND 1879.

Kinds and Amounts of Fertilizing Materials applied per Acre.		O	A	B	C	D	E	F	G	H	
		No Manure.	Nitrate of Soda, 200 lbs.	Dissolved Bone Bl'k, 300 lbs.	Muriate of Potash, 200 lbs.	Nitrate of Soda, 150 lbs. Dissolved Bone Black, 300 lbs.	Nitrate of Soda, 150 lbs. Muriate of Potash, 200 lbs.	Dissolved Bone Bl'k, 300 lbs. Muriate of of Potash, 200 lbs.	Nitrate of Soda, 150 lbs. Dis. Bone Black, 300 lbs. Muriate of Potash, 200 lbs.	Plaster, 200 lbs.	Farm Manures.
Average Produce per Acre.		bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.
CORN,	26 Experiments in 1879,	24.0	30.3	36.9	33.2	38.6	34.1	40.8	46.7	29.1	43.2
	27 Experiments in 1878,	24.6	30.4	33.5	33.3	39.1	39.6	42.9	48.6	28.9	45.9
	53 Experiments in 1878 and 1879,	24.3	30.4	35.2	33.3	38.8	36.8	41.8	47.6	29.0	44.6
POTATOES,	9 Experiments in 1879,	50.7	75.3	88.8	85.2	93.2	83.6	121.1	141.2	69.2	131.6
	9 Experiments in 1878,	100.0	103.0	123.4	129.6	143.2	10.0	153.4	177.3	106.0	132.9
	18 Experiments in 1878 and 1879,	75.4	89.1	106.1	107.4	108.2	94.3	137.2	159.2	82.6	132.2
Average of the Experiments of 1878 & 1879, in which Farm Manures were used. CORN. 37 Exp'ts	Average Produce,	21.3	30.1	34.0	38.7	40.0	23.4	41.5	47.9	24.8	43.5
	Average Increase,	......	8.8	12.7	17.4	18.7	2.1	20.2	26.6	2.5	21.2
POTATOES. 14 Exp'ts.	Average Produce,	75.0	85.7	97.9	109.0	114.9	92.0	134.9	156.6	87.3	131.9
	Average Increase,	......	10.7	22.9	34.0	39.9	17.0	59.9	81.6	12.3	56.9
SWEET POTATOES,	4 Experiments in 1878,	58.7	127.7	89.7	158.2	115.1	194.0	154.1	214.2	60.0	290.0
TURNIPS,	3 Experiments in 1878 and 1879,	245	283	391	274	391	288	401	501	312	374
SUGAR BEETS,	1 Experiment in 1878,	795.3	1013.3	1174.0	851.3	1116.0	988.3	1090.6	1118.6	960.6	
OATS,	2 Experiments in 1879,	19.4	23.6	38.6	17.8	51.8	42.2	30.0	41.8	25.2	26.9
Average Increase per Acre.											
CORN.,	53 Experiments,		6.1	10.9	9.0	14.5	12.5	17.5	23.3	4.7	20.3
OATS,	2 Experiments,,		4.2	9.2	1.6	32.4	22.8	10.6	22.4	5.8	7.5
POTATOES,	18 Experiments,		13.6	30.7	32.0	32.8	18.9	61.8	76.8	12.2	56.8
SWEET POTATOES,	4 Experiments,		72.0	31.0	99.5	56.4	135.3	95.4	155.5	1.3	231.3
TURNIPS,	3 Experiments,		38.0	146.0	29.0	146.0	43.0	156.0	256.0	67.0	129.0
SUGAR BEETS,	1 Experiment,		218.0	378.7	56.0	320.7	193.0	294.3	323.3	164.3	

parallel strips; each strip was divided lengthwise in two of one-twentieth acre each. On one of the halves corn was planted, on the other potatoes. The corn paid scarcely any attention to the potash and very little to the nitrogen, but responded largely to the phosphoric acid. The potatoes were helped in a very marked degree by superphosphate and potash salt, and by nitrogen in all its forms—nitrate of soda, sulphate of ammonia, dried blood, the mixture of all these, and Peruvian guano. Mr. Bartholomew had an experiment with potatoes last year on an adjoining field (see Table IV), which gave precisely similar results. In Mr. Bartholomew's three years' experimenting both crops have uniformly responded to phosphoric acid; but, while corn has paid little heed to nitrogen in commercial fertilizers in any form, and almost none to potash, potatoes have as regularly responded to both. Similar results may be observed in the experiments of Mr. Benson, Nos. 11 and 29, Tables I and II, Prof. Jordan, No. 27, Tables II and IV, and others in 1878 and 1879, in which corn and potatoes were grown side by side.

If potatoes get so much help from nitrogen and potash in Mr. Bartholomew's land where corn can provide itself with these materials without aid from fertilizers, it would seem fair to expect them to respond to the same materials in almost any place where weather and other circumstances favor their growth. Exactly this is the case in the experiments in general, as shown by Tables II, III and IV, herewith, and the corresponding ones in last year's report.

THE EFFECTS OF THE INDIVIDUAL FERTILIZING MATERIALS UPON POTATOES

Are shown in Tables I, II, and III, pages 351, 353, 359.

Nitrate of Soda.—The complete fertilizer G excelled that with muriate of potash and superphosphate, F, by from 10 to 65 bushels per acre in seven cases out of nine. The two failures of nitrate of soda were cases of drouth. In nine experiments in 1878, the complete fertilizer brought more than F by from 20 to 40 bushels per acre in every case but one. In that one the crop seemed to respond to nothing but potash anywhere. As a whole, as appears from the table of differences, the nitrate of soda was much more effective in the complete fertilizer than by itself or in the partial fertilizers. So far as I have observed, nitrate of soda is most helpful to potatoes when there is a plentiful supply of mineral plant food at hand.

What the effect of nitrogen in other forms, as sulphate of ammonia, dried blood, guano, etc., would be, I know of no experiments to decide except the single one of Mr. Bartholomew in Table V. It is extremely probable, however, that nitrogen in diversified forms, as occur in Peruvian guano, would be more efficient than in nitrate of soda, in which it is all in the form of nitric acid. Such are the general indications of Mr. Bartholomew's experiment.

Superphosphate.—In nine experiments in 1879, the yield with the complete fertilizer exceeded that without the superphosphate by from 17 to 128 bushels per acre in every case but one, and then the crop was cut short by drouth. In seven of the nine experiments in 1878, the increase with superphosphate ranged from 21 to 71 bushels per acre. Of the other two, one was that mentioned above where no fertilizer without the muriate of potash had any effect, and even stable manure brought very little increase; in the other the fertilizers were applied in the drill, and the results were indecisive. The superphosphate, like the nitrate of soda, was more effectual in the complete fertilizer than in the partial fertilizers or alone.

Muriate of Potash.—In seven of the nine experiments in 1879, the yield with the complete fertilizer exceeded that without the potash. In both the others drouth prevailed. In seven of the nine trials in 1878, the muriate increased the yield from 38 to 64 bushels. In one of the other two drouth prevailed; in the other none of the fertilizers, nor even stable manure, had any decided effect. And the muriate of potash, like the nitrate of soda and superphosphate, was more effective in the complete fertilizer than in either of the partial fertilizers or alone.

Taking all in all, the potatoes responded to the superphosphates, potash salt, and nitrogenous fertilizers in almost every case where the weather permitted fair growth. None of the other crops except, perhaps, turnips have shown such uniformly beneficial results from all the materials.

The experiments indicate very decidedly that the potato plant differs from many others in respect to the effect of these fertilizing materials upon its growth, and imply that it has less capacity than corn for gathering an adequate supply of food from natural sources. It seems to demand a full and immediately available supply of nourishment for its successful growth.

Concerning the other crops, the data at hand are too meagre to warrant any general conclusions. As regards turnips, however, it is worth noting that the average of three experiments in Table VII show a large increase in every case with superphosphate, very little increase in any without it, but decidedly the most satisfactory outcome with the complete fertilizer. In Mr. Swift's experiment in 1879, and in one by Prof. Farrington in 1877, the turnips gave large yields in every case with superphosphate, and entirely failed in every trial without it. This is quite in accordance with the common notion that makes superphosphate almost a specific for turnips. But it implies that even when the superphosphate is supplied in abundance the turnip is not usually able to gather enough of the other materials for a full yield unless they are close at hand in readily available forms.

MODE OF APPLYING THE FERTILIZERS,—WHETHER BROADCAST, OR IN THE HILL OR DRILL.

The testimony of the experiments is on the whole against applying in the hill or drill. The best results in the majority of cases came where the fertilizers were sown broadcast. Several of the very best were where the materials were scattered over a strip a couple of feet or so wide along the rows. Many of the worst results were where the fertilizers were put in the hill or drill. The nitrate of soda and potash salts thus applied often injured the crops, especially in dry weather. The following from the directions for the experiments is not out of place here:

"The fertilizers may be applied broadcast, or if more convenient, they may be put in the hill or drill, *provided, they are well diffused through the soil.* To accomplish this, they had better be diluted with several times their bulk of earth before using. The important points are, that they be:

"1st. Applied evenly over the plots where they belong and not allowed to get outside.

"2d. Well distributed through the soil."

"Experiments with concentrated fertilizers are often spoiled, just as crops are injured or lost through wrong application. Farmers are apt to think that the manure must be put close to the seed or the plant will not get the benefit of it. This is wrong. It is not the just germinated plantlet that needs the manure, but the plant, from the time it is well started until its growth is done. We want, not only to give the crop a good start, but to help it out on the home stretch as well. The roots and their branching rootlets run out in all directions in search of food, and the fertilizers ought to be where as many of the rootlets as possible can get at them. If we distribute the fertilizers as well as we can, the water in the soil, aided by the chemical and physical forces that nature keeps in operation, will do the rest. In illustration of this remember how well barn-manure acts when applied as a top-dressing long before the seed is put in.

"But if we concentrate the fertilizers in one place fewer roots will get them, and these may be injured by coming in contact with them or with their concentrated solutions in the soil. The roots will find their way to the manure and develop more where it lies, it is true, still we should not oblige them to huddle together in one place, but should rather encourage them to spread around, where with the increased capacity the fertilizer gives them, they can get the more from the soil. Roots join with other natural agents in rendering inert stores of plant food available.

"Above all, do not let the fertilizers come too close to the seed. A coarse, dilute material like yard manure may do the plants no harm, but such concentrated fertilizers as potash salts, dried blood, nitrate of soda, or high grade superphosphates may kill them."

Chemical Fertilizers vs. Farm Manures.

Of course no fair comparisons can be made between the artificial fertilizers whose composition was definite and constant, and the farm manures whose amount and quality were so variable and uncertain. It seems fair to presume, however, that the men who make these experiments would apply liberal doses of good manure on the small plots. The average yield and increase from the farm manures, complete fertilizer, "G," and mixture of superphosphate and potash salt, "F," in the experiments in which the farm manures were used, were:

Bushels (Per Acre.		Farm Manures.	Complete Chemical Fertilizer.	Mixture of Superphosphate and Potash Salt.
CORN,........	Produce,..	43.5	47.9	41.5
	Increase,..	21.2	26.6	20.2
POTATOES,..	Produce,...	131.9	156.6	134.9
	Increase,...	56.9	81.6	59.9
TUPNIPS,....	Produce,...	374.0	501.0	401.0
	Increase,...	129.0	256.0	156.0

The yield and increase of corn, potatoes, and turnips were much larger with the complete chemical fertilizer than from the farm manures. The mixture of superphosphate and potash salt excelled the farm manures with potatoes and turnips, and fell slightly behind them with corn.

Concerning quality of crop, as previously stated, the few experimenters who reported definitely pronounced in favor of the chemicals, especially for potatoes, which they say are smoother and less disposed to rot with the chemicals than with the farm manures.

In nearly all the cases where the weather was reported especially unfavorable on account of excessive cold, wet, or drouth, the chemicals have brought better yields than the farm manures. Farm manures have the advantage over chemical fertilizers in that their organic matter tends to improve the mechanical condition of soils, counteract drouth, and aid in rendering soil-food available, and perhaps to facilitate the assimilation of atmospheric nitrogen also. Concentrated fertilizers have the advantage of supplying the food in readily available forms, while they also aid in improving the texture of the soil and setting plant-food free in various ways not fully understood.

Mr. Lawes of Rothamsted, says that to get large crops he would use artificial fertilizers, rather than farm manures. Ville claims like superiority for the chemicals, and cites averages of some hundreds of experiments in proof. But I have always felt a little skeptical, and must confess that, especially in view of the small quantity of chemicals used in these experiments, the heavy balance in their favor, even in bad weather, has surprised me.

As to how the after effects of the two classes of materials will compare, the future must decide. I should expect the farm manures to be more lasting. Speaking roughly, the mixture of superphosphate and potash salt contains about as much of the mineral elements of plant-food as eight or ten tons of good, well-cured stable manure. The complete fertilizer contains also about one-third or one-fourth as much nitrogen as the same quantity of manure. The bulk of the phosphoric acid and potash of both will stay in the soil until removed by plants. The nitrogen is exposed to more or less rapid loss by entering into insoluble compounds in the soil, by leaching away beyond the reach of plants and by escaping as free nitrogen into the air. It would seem fair to expect that the effect of a dressing of stable manure, with its slower action and larger proportion of nitrogen would last longer than the chemicals.

THE BEST FERTILIZERS TO USE. FERTILIZERS FOR CORN.

The most profitable material in any given case depends first of all upon the soil and season. Leaving these out of account.

(1.) Judging by the average results of the experiments we should expect the largest crops with complete fertilizers. The mixture of Peruvian guano and muriate of potash brought the largest crops. Next in order came the mixture of superphosphate and potash salts with the three nitrogenous materials, nitrate of soda, sulphate of ammonia, and dried blood. Then came the mixture of superphosphate, muriate of potash, and nitrate of soda. The "complete" fertilizer applied at the rate of 300 lbs. superphosphate, 200 lbs. muriate of potash, and 150 lbs. nitrate of soda, and costing $15.38 per acre (including market price plus $5.00 per ton for freight and applying,) brought, on soils good, bad, and indifferent, but mostly very poor, and many unfit for corn, in all sorts of weather, favorable and unfavorable, 47½ bushels of shelled corn against 44½ bushels with farm manures.

(2.) The mixture of 300 lbs. of superphosphate and 200 (or 150) lbs. muriate of potash, was the most profitable one used. The average yield with this was 42 bushels per acre, in all the experiments. In the special corn experiments, which give a fairer test of what it may do on land fitted for corn, the mixture of 300 lbs. superphosphate and 150 lbs. muriate, which can be bought for $8.00 or less, brought on the average a little over 50 bushels per acre.

(3.) The superphosphate proved profitable in perhaps three-fourths of the experiments, the potash salts in two-thirds, and the nitrogen compounds only in a few cases in which the smallest quantities were used.

(4.) In the few instances in which farm manures supplemented by chemical fertilizers have been used for corn, the results have been extremely satisfactory. I am inclined to think that in general the most profitable manuring for corn would be a dressing of farm manures with a proper commercial fertilizer, not in the hill, but broadcast for a little distance about the hill or row, and harrowed in.

FERTILIZERS FOR POTATOES.

In nearly every case where the weather permitted fair growth, the complete fertilizer was the most profitable of all. The number of experiments (18) is not large, but all of both seasons tell the same story, and it would be strange if it should not prove generally true. Granted that potatoes generally respond to all the ingredients, and a formula for the crop becomes a more legitimate thing than for such a crop as corn. If I were to attempt to prescribe, as I certainly do not, I should suggest some such mixture as Nos. 8, 11, 13, or 15, in the special experiments, Table V, page 381.*

RAISING CORN TO MAKE MANURE.

A year ago I ventured the following:

"In the experiments with different fertilizers on corn, it appeared that, with the aid of the inexpensive mineral fertilizers, the corn crop was able to gather considerable nitrogen from natural sources. The yield, with the mixture of superphosphate and potash salts, averaged forty-three bushels of shelled corn per acre. The nitrogen gathered by the whole crop, as computed, averaged fifty-seven pounds per acre. Now suppose the corn to be fed out on the farm. Cotton-seed meal, palm-meal, or bran with the stalks will make them as good as first quality hay. The same materials are excellent to feed with the corn-meal. In this way the corn would gather part of the costly fertilizing ingredients, and the rest would be bought at very small cost. It seems to me this is one of the best possible ways to get good and cheap fodder, and good and cheap manure."

---

*It is a matter of general experience that mixtures work better than single articles. The best data at hand show that fine ground bone, though somewhat slower in action than superphosphate, is yet very efficient. It supplies phosphoric acid at much cheaper rates than superphosphate. A fair article at $35.00 per ton furnishes phosphoric acid at about 6 cents per pound, with a little nitrogen at 12 cents per pound. If finely ground, its action is reasonably rapid, and it does good service. Mr. Charles Fairchild of this place informs me that he has for two seasons past used fine ground bone and muriate of potash for corn, and calculates that his corn costs him about 40 cents per bushel, labor, interest on land, and all other expenses included. Some of his neighbors have had like experience. For nitrogen and phosphoric acid, together with a little potash, Peruvian guano is, taking into account quality and price, the cheapest article in the market. Putting these facts together, it would seem that to get large crops, the cheapest fertilizer would be a mixture of Peruvian guano and muriate of potash, to which some fine bone might be advantageously added. In average circumstances, however, a mixture of potash salt and bone dust or potash salt, bone, and superphosphate would probably be more profitable for corn.

If I were going to use nitrogen I should prefer Peruvian guano to nitrate of soda, sulphate of ammonia, or dried blood, because it is cheaper and doubtless better. For corn, the Lobos brand would in general be more profitable than the 10 per ct. ammonia standard because it has less nitrogen and more phosphoric acid and potash. Next to Peruvian guano, fish guano, fish-scraps, or sulphate of ammonia would be the cheapest source of nitrogen. For potatoes, which seem usually to respond profitably to nitrogen, Peruvian guano, "standard" brand, with potash salt, would doubtless be a good mixture.

The muriates are the cheapest source of potash. An article of 80 per ct. with 50 per ct. of actual potash, at $35.00 per ton gives potash at 3½ cts per pound. The sulphates are generally recommended in preference to the muriates on the ground that they have a better effect on the quality of the crops. It is stated that the muriate tends to decrease the amount of starch and make the potato less mealy. I hear no complaint of this sort from the experimenters. All who have said anything give good accounts of the quality of the potatoes. The sulphates cost more than the muriates, are harder to get pure, and have less potash. I have lately seen an excellent quality of sulphate offered at about $65.00 per ton, which would bring the potash 43-44 per ct. at 7½ cts. per lb. Whether it would be profitable to get this rather than the muriate for potatoes, I cannot say. For corn, grain, and root crops the muriate is satisfactory.

As to quantities, the most striking results with potash salts have happened to be some in which only 150 lbs. per acre were used. Three hundred pounds of superphosphate is a fair dressing; often 200 lbs. works well; 400 lbs. is on the whole rather large for a hoed or grain crop, still many farmers use more than this.

This season, the average produce with the mixture of superphosphate and potash salt was about the same as last. But in the special experiments, which are a fairer test of what the fertilizers will do for corn on soils and in latitudes adapted to its growth, we have an average yield of about 50 bushels of shelled corn from an application of 300 lbs. of superphosphate, and 150 lbs. of muriate of potash per acre, which would cost, say $8.50. Estimating the amount of stover in accordance with the experimenter's figures, page 371, we have on the average with the crop of 50 bushels of shelled corn, estimating roughly:

		Nitrogen.	Phos. Acid.	Potash.
Removed with crop.	Corn, 50 bushels=2,800 lbs.,	45 lbs.	17 lbs.	11 lbs.
	Stover (incl. cobs), 4,500 lbs.,	20 lbs.	23 lbs.	39 lbs.
	Total,	65 lbs.	40 lbs.	50 lbs.
Applied in fertilizers,		none.	48 lbs.	75 lbs.

The soil has received more of the mineral elements than it has lost. At the same time some of its locked-up store has been set free. It is richer in available mineral elements than it was before the corn was grown. How it stands with respect to nitrogen we do not know, because we do not know where the nitrogen came from. Doubtless both crop and soil gathered some from the air, how much we have yet to learn. Clover thrives well with mineral fertilizers alone, and leaves the soil apparently richer in nitrogen after it is gone than before it was sown. Corn seems allied to clover in its power to gather its own nitrogen, and in the effect of fertilizers upon its growth. It is hardly probable that the fifty bushel crop has left the soil very much worse off in nitrogen than it was before. With the fifty bushels of corn there will be, besides cobs, say, one and seven-eighths tons of stalks, which, if well cured, are worth, according to analyses and feeding experiments, four-fifths as much as good upland hay, or $8.00 per ton, where the hay is worth $10.00. Reckoning the stalks at only $6.00 per ton, and the corn at 60 cts. per bushel, the value of the crop will be $41.25, at a cost of, say $8.50 for fertilizer. But this is not all. Let the corn and stalks be fed out upon the farm, and the manure be carefully economized, and three-fourths of its fertilizing materials, at least, ought to get back to the soil. Two-thirds of the nitrogen, phosphoric acid, and potash in the crops, would at the rates at which they are bought in equally valuable forms in commercial fertilizers, be worth just about $8.50, the cost of the fertilizer.

That is to say, the crop probably leaves the land in as good condition as it was before, the manure is worth more than the cost of the fertilizer, and there remains over $40.00 worth of fodder to pay for labor and rent on the acre of land. Is it not better policy to raise corn in this way than to buy it from the West?

THE GENERAL RESULTS OF THE EXPERIMENTS OF 1878 AND 1879

May be summed up as follows:

1. It must be remembered that the trials were not only subject to all the vicissitudes of weather and season, heat and cold, wet and drouth, but were made on soils of all sorts but mostly very much run down. The directions were to select worn-out soils. Hence, the average results with a given crop do not fairly represent what might be expected on soils adapted to its growth.

2. As would be expected, the results of the two seasons agree in the main, though with the less favorable weather of 1879 the crops averaged less than those of 1878.

AS RESPECTS THE EFFECTS OF THE DIFFERENT FERTILIZERS.

3. The "complete chemical fertilizer," the mixture of 300 lbs. superphosphate, 150 to 200 lbs. potash salt, and 150 lbs. nitrate of soda, costing $15.38 or less per acre, (including $5 per ton for freight,) brought the largest crops, excelling even the farm manures, with all the crops on which the number of experiments is large enough for a fair comparison. But it must be remembered that this mixture was proposed to test soils and not to bring large yields, and does not show how well chemical fertilizers may do. The "complete fertilizers" prepared by reliable dealers for special crops, are, of course, more appropriate for them and would give better results than this mixture.

4. The mixture of 300 lbs. superphosphate and 150–200 lbs. potash salt, costing $8.00–$9.25 per acre, brought on the average a trifle less corn and decidedly more potatoes than the farm manure.

5. The mixture of nitrate of soda and superphosphate, which corresponds closest of all to the ordinary ammoniated superphosphates, fish manures and guano, though costing more than the mixture of superphosphate and potash salt, brought less increase of corn, potatoes, turnips, sweet potatoes, and indeed less of every crop but oats. The number of experiments with oats, however, is too small for any general conclusions. It is very probable that oats and the cereals generally would be more helped by the nitrogen and less by the potash. But it is a question whether manufacturers of ammoniated phosphates would not do better to substitute potash salts for the nitrogenous materials in compounding their fertilizers, at least for some crops.

6. The mixture of nitrate of soda and potash salt was the least efficient of all.

7. As to the efficiency of the materials separately, the nitrate of soda was rarely, the sulphate of lime frequently, the muriate of potash very often, and the superphosphate generally, useful. Doubtless considerable of the effect of the superphosphate was due, in many cases, to the sulphuric acid and lime.

8. The results with ashes are variable, though generally speaking, they have been efficacious.

9. One of the chief defects of these experiments is that so few parallel trials with lime have been made. There are many cases in which a dressing of lime is the cheapest and best means of improving the land.

ARTIFICIAL FERTILIZERS VS. FARM MANURES.

10. Not only did the complete chemical fertilizer bring a larger average increase than farm manures as actually used, and the mixture of superphosphate and potash salt nearly as large, but the quality of the crop was generally better with the chemicals. Potatoes especially were finer in quality and less disposed to rot with the artificial fertilizers than with the farm manures.

AS TO THE EFFECTS OF THE FERTILIZERS UPON DIFFERENT CROPS.

11. Potatoes and turnips responded most profitably to the complete fertilizer in nearly every case. Corn, on the other hand, was

largely helped by the superphosphate and potash salt, but received but little benefit from the application of nitrogen in any form.

AS TO THE FEEDING CAPACITIES OF THE CROP.

12. The experiments imply that corn, somehow or other, was able to gather a fair supply of nitrogen from natural sources provided it had enough of the mineral ingredients at its disposal. They do not tell how much of the nitrogen came from the roots of preceding crops, how much from other nitrogen compounds in the soil, and how much from the air. They imply that the potato possesses in far less degree than corn the power of gathering sufficient supply of either nitrogen or the other ingredients of its food from soil and air. They imply that turnips are generally unable to provide themselves with phosphoric acid from the soil, and are greatly helped by it in fertilizers; that without an abundance of phosphoric acid they get but little good from other materials; that with it they can gather a partial supply of the other materials of their food, but that for a full yield considerable quantities of all the soil ingredients of plant-food are needed close at hand, and in available forms. Except on corn and potatoes, the experiments are still too few for reliable inferences.

THE BEST FERTILIZERS FOR DIFFERENT CROPS.

13. The most profitable material in a given case is that which is best fitted to its needs. The chief factors of the problem are first, soil; second, climate and season; third, feeding capacity of crop; fourth, form of combination of the ingredients of the fertilizer; fifth, the indirect action of the fertilizer, i. e. its effect : *a*, upon the texture of the soil ; *b*, upon its power to absorb and retain plant food ; *c*, in setting other plant-food free ; and sixth, the composition of the plant.

Soils vary in respect to the *plant-food* they supply in available forms. Phosphoric acid is most often deficient ; next come potash and nitrogen; then lime and sulphuric acid, and rarely magnesia.

But the infertility of soils is due to other causes perhaps nearly as often as to lack of plant food. Soils often do not have the proper texture—they are too compact or too loose; or they are too shallow; or they lack absorptive power—they cannot retain the plant-food until plants use it, but suffer it to be leached away by drainage water; or the moisture supply is bad—they are too wet or too dry.

These defects are as fatal as lack of plant food. Many soils need amendments first and then manure.

Climate and season counts for much, often for everything, in the action of manures. This fact is certain. Of the reasons we know as yet, but little.

As to effects of the *forms of combination*, nitrogen seems to do better in materials that contain it in several forms, as Peruvian guano, or a mixture of nitrate of soda, sulphate of ammonia, and dried blood, than in either of the latter substances singly. The effects of phosphoric acid and potash in different forms, were tested in too few cases to warrant any conclusions.

As to the *indirect action* of fertilizers in improving the texture of the soil and setting its plant food free, the experiments have nothing to say, but we know that it often makes a large part of the usefulness of the fertilizer.

14. Leaving differences of soils out of account and considering the average results of the experiments, an excellent fertilizer to produce large crops of corn, among the materials used would, probably be a mixture of Peruvian guano and potash salt, with perhaps the addition of some fine ground bone or superphosphate. The most profitable mixture would consist of muriate of potash with either superphosphate or fine ground bone, or both.

15. For potatoes, which responded well to all the materials, probably a mixture of Peruvian guano or fish with potash salts would be generally profitable. For either corn or potatoes, nitrate of soda, sulphate of ammonia, dried blood, or better, a mixture of these, could be advantageously used to supply the nitrogen, and superphosphate or bone-dust or a mixture of the two, for the phosphoric acid.

16. There are many cases in which complete fertilizers are in place. There are also many in which the farmer does not know what his soil and crops need and can better afford to pay for some unnecessary materials in a complete fertilizer than to risk the loss of his crop. But for this demand dealers offer a supply. Instead of proposing formulas, I urge farmers to study their soils and circumstances and learn what is best for them to use.

17. The common impression among farmers that the best use of artificial fertilizers is to supplement farm manures is doubtless, in ordinary circumstances, correct.

AS RESPECTS SOILS—WHAT TO USE ON THEM.

18. Soils vary widely in their capacities for supplying crops with food, and consequently in their demands for fertilizers.

19. Some soils will give good returns for manuring; others, without previous draining, irrigation, or amendment, by tillage, or use of lime, marl, or otherwise, will not.

20. Farmers cannot afford to use commercial fertilizers at random, and it is time they understood the reason why.

21. The right materials in the right places bring large profits. Artificial fertilizers rightly used must prove among the most potent means for the restoration of our agriculture.

22. The only way to find what a soil wants is to study it by careful observation and experiments.

23. Success in farming as in other business requires the use of brains. In fact it was to illustrate this more than anything else that the experiments were planned.

NOTE. The details of experiments can be found in extras, to be obtained from Prof. Atwater, or the Secretary.

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(2)

STATE OF CONNECTICUT.

ANNUAL REPORT

OF

THE CONNECTICUT AGRICULTURAL

EXPERIMENT STATION

FOR 1879.

PRINTED BY ORDER OF THE LEGISLATURE.

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1880.

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OF

The Connecticut Agricultural Experiment Station,

1879.

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Mr. Judd declined re-election to the Board of Control in December, 1879, and Prof. W. O. Atwater was appointed in his place. The other officers for 1880 are as above.

ANNOUNCEMENT.

The Connecticut Agricultural Experiment Station was established in accordance with an Act of the General Assembly, approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, soils, waters, milks, and other agricultural materials and products, to identify grasses, weeds, and useful or injurious insects, and to give information on the various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

All chemical analyses, seed examinations, etc., proper to an Experiment Station, that can be used for the public benefit, will be made without charge. Work done for the use of individuals will be charged for at moderate rates. The Station will undertake no work, the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Samples of Commercial Fertilizers, Seeds, etc., will be examined in the order of their coming; but when many samples of one brand or kind are sent in, the Station will make a selection for analysis. In taking samples of Commercial Fertilizers and Seeds for examination, the Station's "Instructions for Sampling" must be strictly followed, and its blank "Forms for Descriptions of Samples" must be filled out and sent with the samples.

The results of each analysis or examination will be promptly communicated to the party sending the sample. Results that are of general interest will be sent simultaneously to all the newspapers of the State for publication.

The officers of the Station will take pains to obtain for analysis, samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of the farmers is essential for the full and timely protection of their interests. Farmers' Clubs and like Associations can efficiently work with the Station for this purpose, by sending in samples early during each season of trade.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties, sent on application.

☞ Parcels by Express, to receive attention, should be prepaid, and all communications should be directed to

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

Laboratory and Office, in East Wing of Sheffield Hall, Grove St., head of College St.

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ERRATA.

Page 23, line 8 from top, for quarter read greater.
Page 27, in analysis of 294 for 2 read 24.
Page 30, line 1 of first table, for $12.67 read $22.67.
Page 30, last line of same table, for $35.00 read $30.00.
Page 43, line 14 from bottom, for 21.77 read 21.97.
Page 46, line 10 from top, for 23.00 read 23.90.
Page 47, line 5 from bottom, for in read as.
Page 50, line 18 from bottom, insert * before "containing nitrogen."
Page 51, line 13 from top, insert * before "containing nitrogen."
Page 53, line 4 from bottom, for 304 read 300.
Page 68, line 11 from top, for plants read fruit.
Page 70, line 16 from bottom, for limits read limit.
Page 70, line 15 from bottom, for tend read tends.
Page 73, line 4 from top, for cent read cents.
Page 76, in description of sample LXII add, and timothy, after clover.
Page 76, to description of sample LII add, sent by T. S. Gold, West Cornwall.
Page 89, in analysis of White Ohio, read 79.05 instead of 78.95.
Page 90, line 2 from top, for 11 read 13.
Page 96, strike out lbs. in last column of table.
Page 112, note to table, for 143 read 14.3.
Page 112, line 7 of table, for LVIII read LVII.
Page 113, line 4 of second table, for 3.616 read 3.686.
Page 114, line 21 from bottom, for investigation read investigations.
Page 115, line 11 from top, for Mercker read Märcker.

REPORT OF THE BOARD OF CONTROL.

To the General Assembly of the State of Connecticut:

The Board of Control of THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION has the honor to submit the following Report.

During the year 1879, the work of the Station has gone on without interruption, and, as heretofore, under the direction of Professor S. W. Johnson. He was assisted the whole year by Messrs. E. H. Jenkins and H. P. Armsby, by Mr. H. L. Wells for seven and one half months, and by Messrs. S. L. Penfield and W. T. Sedgwick, for shorter periods.

The full Board has held one meeting and the Executive Committee thirteen meetings during the year, one at least in each month.

For the expenses and work of the Station we refer your honorable body to the appended Reports of the Treasurer and Director, presented to this Board at its annual meeting held in Hartford, Jan. 20th, 1880.

By arrangement with the State Board of Agriculture, and with the approval of the Comptroller, the printed report of the Experiment Station will be bound up with the Report of the Board of Agriculture, and will be distributed with that Report from the office of the Secretary of the Board of Agriculture.

By order of the Board.

CHARLES B. ANDREWS,
President.

WILLIAM H. BREWER,
Secretary.

TREASURER'S REPORT.

Wm. H. Brewer, *in account with the Connecticut Agricultural Experiment Station.*

Receipts.

Balance from last Report, ...	$463.28	
Laboratory Receipts, ...	422.35	
From State Treasurer, ...	5,000.00	
		$5,885.63

Payments.

Salaries, ...	$4,135.00	
Travelling Expenses of the Board, ...	48.50	
Stationery, Printing and Postage, ...	168.23	
Gas and Fuel, ...	214.42	
Laboratory Expenses, ...	771.57	
Miscellaneous, ...	20.20	
Cash on hand, ...	527.71	
		$5,885.63

There is now due the Station twenty (20) dollars for chemical analyses, and the bills outstanding against the Station are estimated to amount to about five hundred and forty (540) dollars. The Station is in possession of furniture which cost one hundred and thirty seven (137) dollars, and of apparatus, laboratory stock and office appurtenances, not classed as furniture, estimated to be worth about one thousand (1,000) dollars.

WILLIAM H. BREWER,
Treasurer.

New Haven, Jan. 19th, 1880.

T. S. Gold,
Edwin Hoyt,
Auditing Committee.

REPORT OF THE DIRECTOR.

In presenting his Report for 1879, the Director would remark that since the Station and its work are still imperfectly known to the citizens of Connecticut, it is desirable and even necessary to repeat here various statements and explanations which have appeared in one or both his former Reports. Accordingly the reader will find in the following pages such extracts or repetitions from the previous Reports as will be serviceable for those who have not had opportunity to see the former publications of the Station, which, from having been issued in small editions, cannot now be supplied.

The present (3d) Report covers the doings of the Station for the twelve-month ending Dec. 31st, 1879.

The Objects and Uses of the Station, and the Privileges which it offers to the citizens of Connecticut, are concisely set forth in the Announcement which is to be found on page 3.

The most important subjects which have engaged attention at the Station during the year 1879, are briefly stated in the paragraphs that immediately follow. Reference to the Table of Contents will direct to their details and show what other topics are considered in this Report.

Summary of Station Work.—As in former years the analysis of *Fertilizers* has been the leading feature in our operations. One hundred and seventeen (117) samples including nearly all the varieties of purchased fertilizers used by our farmers, have come under the scrutiny of the Station.

Of *Feeding Stuffs* thirty-three (33) specimens have been analyzed, mainly with a view to increase our knowledge of the two most important standard field crops of the State, viz., maize and hay.

Eight (8) samples of *Seeds* have been examined as to their purity and vegetative power.

Thirteen (13) samples of *River and Well Waters* have been tested in respect to their fitness for domestic use.

The study of *Methods of Chemical Analysis* used in the examinations of fertilizers and feeding-stuffs, has received much attention and on subsequent pages some of the processes employed or investigated in the Station Laboratory are described for the benefit of chemists who are occupied with similar work.

In connection with an investigation of the various processes that have been proposed for finding the quantities of nitrogenous principles in feeding-stuffs, Dr. Armsby has, at my request, prepared a critical account of the work recently done elsewhere in respect to the *Nutritive Value of the so-called Amides.*

Dr. Jenkins has collected and arranged in systematic tabular form the results of, I believe, all the trustworthy analyses of feeding-stuffs which have been hitherto made and published in America, with references to the original sources.

This undertaking grew out of the necessity of bringing these analyses together for the use of the Station in prosecuting its work, and the tables of analyses are printed in this Report for the benefit of the many agriculturists in this State who are making use of the information which chemistry is able to supply to the keeper of live stock. Not only are the analyses given as originally published, or in some instances with typographical errors corrected, but in the many cases where it was needful, they have been recalculated to a water-free basis, in order to make comparisons possible.

Readers who may know of trustworthy analyses not here included, will do a great favor by communicating them or reference to them, to the Station.

The important study of the *Relations of the soil to Water* which occupied a considerable space in former Reports, has not been continued experimentally, during 1879, for the reason that the Station is quite destitute of the means of prosecuting further work in that line to advantage. The results already reached and published in the two former Reports have prepared us to continue the investigation with the prospect of developing facts and laws that may be highly useful in agricultural practice. But to continue the study of the subject requires a small piece of inclosed land with an exposure unshaded by trees or buildings, and also a small plant house. The want of these appurtenances effectually bars the station from undertaking any observations or experiments on soils or plants under conditions at all resembling those which occur in agriculture.

Station Bulletins.—During the season of 1879, from March to November, the Station has issued 15 printed bulletins which were simultaneously sent to 83 daily and weekly newspapers published in Connecticut, and to the Secretaries of 26 Farmers' Clubs, and 31 Agricultural Societies belonging to the State. These Bulletins were also sent in exchange to a number of the Agricultural Journals in adjoining States. They have been extensively reprinted and thus brought under the eyes of a very large number of agricultural readers. The Bulletins of the Station have been occupied with analyses of fertilizers and feeding stuffs and have served to put before the public, in a very compact form, a good share of the most immediately "practical" results of our year's work and this at times when they would best serve a practical purpose.

Correspondence.—As in former years a large number of letters have been written in answer to inquiries from farmers and gardeners, with reference to the use and value of fertilizers and feeding stuffs, and other subjects of agricultural practice. A number of these inquiries and answers, having general interest, have been printed in the "Connecticut Farmer," and are reproduced in this Report.

Means of Publication.—In my first Report I expressed regret that our State had no "Agricultural paper of its own which could serve as the organ of the Experiment Station, and the means of weekly communication between it and the farmers." I wrote further that "while the Annual Report serves to publish the detailed results of the work of the Station, and while, by means of bulletins and communications to the newspapers the more important results of investigations may be diffused, yet the Connecticut Experiment Station cannot reach its full efficiency until every farmer in the State is able to find in some one publication a ready means of learning promptly what is doing in the way of testing fertilizers, seeds, etc., and of asking and having answered in its columns questions which would not be appropriate nor timely in an annual volume."

In February began the weekly issue of the "Connecticut Farmer," an agricultural and family newspaper published at Hartford, which has supplied this want. The "Connecticut Farmer" from the outset has accorded to the Station, every desired facility for publishing our results, and I have accordingly sent to that paper the manuscript bulletins and in return have been supplied with printed copies for distribution. It has thus been possible to make our bulletins more detailed and complete and to publish them more frequently and more accurately than hitherto.

I must take this opportunity to express the hope that the "Connecticut Farmer" may meet with generous support both from the purses and the pens of all our citizens who are interested in farming or gardening. If the Experiment Station is indispensable as a source of important information to the land-owners of Connecticut, the agricultural paper of the State will be equally needed as a right hand to distribute that information to our citizens, and to convey a knowledge of their wishes and necessities to the Station.

COMMERCIAL FERTILIZERS.

In respect to its terms, the Station makes two classes of analyses of fertilizers and fertilizing materials; the first for the benefit of farmers, gardeners, and the public generally; the second for the private use of manufacturers and dealers. Analyses of the first class are made gratuitously, and the results are published as speedily and widely as possible, for the guidance of purchasers and consumers. Those of the second class are charged for at moderate rates, and their results are not published in a way to interfere with their legitimate private use. The Station, however, distinctly reserves the liberty to use, at discretion, all results obtained in its Laboratory, for the public benefit, and in no case will enter into any privacy that can work against the public good.

During 1879, one hundred and seventeen (117) samples of fertilizers have been analyzed. Of these, thirty-seven (37) were examined for private parties, and the remainder, eighty (80), for the general use of the citizens of the State.

The samples analyzed for the public benefit have been sent in from all quarters of the State, in most instances by actual purchasers and consumers. In some instances, dealers or agents have sent in samples, and in a few cases, the Officers of the Station have sampled fertilizers in the stores at New Haven.

All the analyses of the first class are made on samples understood to have been taken in accordance with the printed Instructions which the Station supplies to all applicants. Here follows a copy of these instructions.

INSTRUCTIONS FOR SAMPLING COMMERCIAL FERTILIZERS.

The *Commercial Value* of a high priced Fertilizer can be estimated, if the percentages of its principal fertilizing elements are known. Chemical analysis of a small sample, so taken as to fairly represent a large lot, will show the composition of the lot. The subjoined instructions, if faithfully followed, will insure a fair sample. Especial care should be observed that the sample neither gains nor loses *moisture* during the sampling or sending, as may easily happen in extremes of weather, or from even a short exposure to sun and wind, or from keeping in a poorly closed vessel.

1. Provide a tea cup, some large papers, and for each sample a glass fruit can or tin box, holding about one quart, that can be tightly closed, all to be clean and dry.

2. Weigh separately at least three (3) average packages (barrels or bags) of the fertilizer, and enter these *actual weights* in the "Form for Description of Sample."

3. Open the packages that have been weighed, and mix well together the contents of each, down to one-half its depth, emptying out upon a clean floor if needful, and crushing any soft, moist lumps in order to facilitate mixture, but leaving hard, dry lumps unbroken, so that the sample shall exhibit the texture and mechanical condition of the fertilizer.

4. Take out five (5) equal cupfuls from different parts of the mixed portions of each package. Pour them (15 in all) one over another upon a paper, intermix again thoroughly but quickly to avoid loss or gain of moisture, fill a can or box from this mixture, close tightly, *label plainly*, and send, charges prepaid, to

The Conn. Agricultural Experiment Station, New Haven Conn.

The foregoing Instructions may be over-nice in some cases, but they are not intended to take the place of good sense on the part of those who are interested in learning the true composition of a fertilizer. Any mode of operating that will yield *a fair sample* is good enough.

In case of a fine, uniform and moist or coherent article, a butter-tryer or a tin tube, like a dipper handle, put well down into the packages in a good number of places will give a fair sample with great ease. With dry, coarse articles, such as ground bone, there is likely to be a separation of coarse and fine parts on handling. Moist articles put up in bags or common barrels may become dry on the outside. It is in these cases absolutely necessary to mix thoroughly the coarse and fine, the dry and the moist portions before sampling. Otherwise the analysis will certainly misrepresent the article whose value it is intended to fix.

The quantity sent should not be too small. When the material is fine and uniform, and has been carefully sampled, a pint may be enough, but otherwise and especially in case of ground bone, which must be mechanically analyzed, the sample should not be less than one quart.

It is also important that samples for analysis should be taken at the time when the fertilizer is purchased, and if they cannot be at once dispatched to the Station, they should be so preserved as to suffer no change. Moist fish, blood or cotton seed will soon decompose and lose ammonia, if bottled and kept in a warm place. Superphosphates containing much nitrogen will suffer reversion of their soluble phosphoric acid under similar circumstances. Most of the moist fertilizers will lose water unless tightly bottled, but some of the grades of potash salts will gather moisture from the air and become a slumpy mass if not thoroughly protected.

These changes in the composition of a sample not suitably preserved, must invalidate any conclusions from its analysis, and work serious injustice either to the manufacturer or to the consumer.

It doubtless often happens that a purchaser on laying in his stock of boughten fertilizers, reasons that he will not then trouble the Station to analyze the goods he has obtained, but will set aside samples which he can send for examination in case the crops report adversely as to their quality. It is always better to send all samples at once to the Station where they can be directly analyzed or so prepared that they shall keep without chemical change.

With the Instructions for Sampling, the Station furnishes a blank Form for Description of Samples, a copy of which is here given.

Form for Description of Sample.

Station No.………………Rec'd at Station,…………………………18

Each sample of Fertilizers sent for gratuitous analysis must be accompanied by one of these Forms, with the blanks *below* filled out fully and legibly.

The filled out Form, if wrapped up with the sample, will serve as a label.

Send with each sample a specimen of any printed circular, pamphlet, analysis, or statement that accompanies the fertilizer or is used in its sale.

Brand of Fertilizer,……………………………………………………

Name and address of Manufacturer,………………………………………

……………………………………………………………………………

Name and address of Dealer from whose stock this sample is taken, ……………………………………………………………………

Date of taking this sample,…………………………………………

Selling price per ton or hundred, bag or barrel.……………………

Selling weight claimed for each package weighed,…………………

Actual weight of packages opened, ……………………………………

Here write a copy of any analysis or guaranteed composition that is fixed to the packages.

……………………………………………………………………………

Signature and P. O. address of person taking and sending the sample.

……………………………………………………………………………

On receipt of any sample of fertilizer from the open market, the filled out "Form for Description," which accompanies it, is filed in the Station's Record of Analyses and remains there as a voucher for the authenticity of the sample and for the fact that it has been taken fairly, or, at least, under suitable instructions. It is thus sought to insure that manufacturers and dealers shall not suffer from the publication of analyses made on material that does not correctly represent what they have put upon the market.

The "Form for Description" when properly filled out also contains all the data of cost, weight, &c., of a fertilizer which are necessary for estimating, with help of the analysis, the commercial value of its fertilizing elements, and the fairness of its selling price. Neglect to give full particulars occasions the Station much trouble, and it is evident that want of accuracy in writing up the Description may work injustice to manufacturers or dealers as well as mislead consumers. It is especially important that the *Brand* of a fertilizer and its *Selling price* should be correctly given. The price should be that actually charged by the dealer of whom it is bought, and if the article be purchased in New York or other distant market, that fact should be stated and the cost at the nearest point to the consumer, on rail or boat, should be reported also.

In all cases *ton-prices* should be given, and if the sale of an article is only by smaller quantities, that fact should be distinctly mentioned.

When a sample of fertilizer has been analyzed, the results are entered on a printed form, which is filed in the Station Record of Analyses, facing the "Description of Sample" that was received with the fertilizer to which it pertains, and there remains for future reference.

A copy of the analysis is also immediately reported to the party that furnished the sample, the report being entered on one page of another printed form and facing a second printed page of "Explanations" intended to embody the principles and data upon which the valuation of Fertilizers is based.

These Explanations are essential to a correct understanding of the analyses that are given on subsequent pages and are therefore reproduced here.

EXPLANATIONS OF FERTILIZER-ANALYSIS AND VALUATION.

Nitrogen is commercially the most valuable fertilizing element. It occurs in various forms or states. *Organic nitrogen* is the nitrogen of animal and vegetable matters generally, existing in the albumin and fibrin of meat and blood, in the uric acid of bird dung, in the urea and hippuric acid of urine, and in a number of other substances. Some forms of organic nitrogen, as that of blood and meat, are highly active as fertilizers; others, as that of hair and leather, are comparatively slow in their effect on vegetation, unless these matters are reduced to a fine powder or chemically disintegrated. *Ammonia* and *nitric acid* are results of the decay of *organic nitrogen* in the soil and manure heap, and are the most active forms of Nitrogen. They occur in commerce —the former in sulphate of ammonia, the latter in nitrate of soda. 17 parts of ammonia contain 14 parts of nitrogen.

Soluble Phosphoric acid implies phosphoric acid or phosphates that are freely soluble in water. It is the characteristic ingredient of Superphosphates, in which it is produced by acting on "insoluble" or "reverted" phosphates with oil of vitriol. It is not only readily taken up by plants, but is distributed through the soil by rains. Once well incorporated with soil it shortly becomes reverted phosphoric acid.

Reverted (reduced or precipitated) Phosphoric acid, means strictly, phosphoric acid that was once freely soluble in water, but from chemical change has become insoluble in that liquid. It is freely taken up by a strong solution of ammonium citrate, which is therefore used in analysis to determine its quantity. "Reverted phosphoric acid" implies phosphates that are readily assimilated by crops, but have less value than soluble phosphoric acid, because they do not distribute freely by rain.

Insoluble Phosphoric acid implies various phosphates not freely soluble in water or ammonium citrate. In some cases the phosphoric acid is too insoluble to be readily available as plant food. This is true of the South Carolina rock phosphate, of Navassa phosphate, and especially of Canada apatite. The phosphate of coarse, raw bones is at first nearly insoluble in this sense, because of the animal matter of the bone which envelopes it, but when the latter decays in the soil, the phosphate remains in essentially the "reverted" form.

Potash signifies the substance known in chemistry as potassium oxide, which is the valuable fertilizing ingredient of "potashes" and "potash salts." It is most costly in the form of sulphate, and cheapest in the shape of muriate or chloride.

The Valuation of a Fertilizer signifies estimating its worth in money, or its trade-value; a value which, it should be remembered, is not *necessarily* proportional to its fertilizing effects in any special case.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and other fertilizers, for which $30 to $80 per ton are paid, depend chiefly for their trade-value on the three substances, *nitrogen*, *phosphoric acid* and *potash*, which are comparatively costly and steady in price. The money-value per pound of these ingredients is easily estimated from the market prices of the standard articles which furnish them to commerce.

The average Trade-values or cost in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash, as recently found in the Connecticut and New York markets, and employed by the Station during 1879 and which it is proposed to use in 1880, are as follows:

TRADE-VALUES FOR 1879 and 1880.—*See page* 55.

	Cents per pound.
Nitrogen in nitrates,	26
" in ammonia salts,	22½
" in Peruvian Guano, fine steamed bone, dried and fine ground blood, meat and fish,	20
" in fine ground bone, horn and wool dust,	18
" in fine medium bone,	17¼
" in medium bone,	16½
" in coarse medium bone,	15¾
" in coarse bone, horn shavings, hair and fish scrap,	15
Phosphoric acid soluble in water,	12½
" " "reverted" and in Peruvian Guano,	9
" " insoluble, in fine bone and fish guano,	7
" " " in fine medium bone,	6½
" " " in medium bone,	6
" " " in coarse medium bone,	5½
" " " in coarse bone, bone ash and bone black,	5
" " " in fine ground rock phosphate,	3½
Potash in high grade sulphate,	7½
" in low grade sulphate and kainite,	6
" in muriate or potassium chloride,	4½

These "trade values" of the elements of fertilizers are not fixed, but vary with the state of the market, and are from time to time subject to revision. They are not exact to the cent or its fractions, because the same article sells cheaper at commercial or manufacturing centers than in country towns, cheaper in large lots than in small, cheaper for cash than on time. These values are high enough to do no injustice to the dealer, and accurate enough to serve the object of the consumer.

To Estimate the Value of a Fertilizer we multiply the per cent. of Nitrogen, &c., by the trade-value per pound, and that product by 20, we thus get the values per ton of the several ingredients, and adding them together we obtain the total estimated value per ton.

In case of *Ground bone*, the fineness of the sample is graded by sifting, and we separately compute the nitrogen value of each grade of bone which the sample contains, by multiplying the pounds of nitrogen per ton in the sample, by the per cent. of each grade, taking one one-hundredth of that product, multiplying it by the estimated value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade, thus obtained, together with the values of each grade for phosphoric acid, similarly computed, the total is the estimated value of the sample of bone.

The uses of the " Valuation " are, 1st, to show whether a given lot or brand of fertilizer is worth as a commodity of trade what it costs. If the selling price is no higher than the estimated value, the purchaser may be quite sure that the price is reasonable. If the selling price is but $2 to $3 per ton more than the estimated value it may still be a fair price, but if the cost per ton is $5 or more over the estimated value, it would be well to look further. 2d, Comparisons of the estimated values and selling prices, of a number of fertilizers, will generally indicate fairly which is the best for the money. But the " estimated value " is not to be too literally construed, for analysis cannot always decide accurately what is the *form* of nitrogen, &c., while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

The Agricultural value of a fertilizer is measured by the benefit received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that Peruvian guano, superphosphates, fish-scraps, dried blood, potash salts, plaster, &c., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

For the above first-named purpose of valuation the trade-values of the fertilizing elements which are employed in the computations, should be as exact as possible and should be frequently corrected to follow the changes of the market. For the second-named use of valuation frequent changes of the trade-values are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth, when their valuations are estimated from different data. The greatest good of the greatest number is best served, in an Annual Report, by a middle course, especially since, in such a document, the fluctuations in trade-value that may occur within the year, cannot be accurately followed, and the comparisons of estimated values are mostly in retrospect.

Further remarks upon Valuation will be found in subsequent pages, where the actual cost of various fertilizing elements during 1879, is compared with the trade values that were proposed a twelve-month ago.

ANALYSES AND VALUATION OF FERTILIZERS.

The fertilizers analyzed in the Station Laboratory during the year 1879 are as follows, viz:

22 superphosphates.
4 guanos.
12 ground bone.
13 dried fish scrap.
12 dried blood.
3 hair and horn.
3 G. W. Baker's animal manures.
2 damaged cotton and linseed meal.
1 hen dung.
5 sulphate of ammonia.
5 potash salts.
3 oyster shell lime.
2 paper mill waste.
1 shell marl.
3 leached wood ashes.
3 unleached wood ashes.

1	Jersey green-sand marl.
1	marine mud and seaweed.
3	fresh water sediments.
3	peats or swamp mucks.
2	catch basin sediments.
1	native phosphate.
12	" special manures " or " formulas " for particular crops.
117	

Here follow the details of those analyses which have any general interest, together with such remarks as may be useful in explanation.

SUPERPHOSPHATES.

Of the twenty-two samples of this kind of fertilizer that have been examined, five were analyzed for the private use of manufacturers. The analyses of the remaining seventeen samples are here tabulated on page 22. Here follow the names or brands which designate the Superphosphates, together with the address of the parties by whom they were sampled and sent. The numbers, in full-faced type, are those by which the samples are entered on the Station Record.

Superphosphates.

No.	Name or Brand	Sampled by
228	Lebanon Fertilizer.	C. P. Augur, Whitneyville.
229	" "	" "
248	Dissolved Bone, Booth & Edgar's.	W. E. Wheeler, Stratford.
249	Staggs' Superphosphate.	" "
251	Ammoniated Superphosphate, N. H. Chemical Co's.	J. J. Webb, Hamden.
271	Ammoniated Superphosphate, N. H. Chemical Co.'s	T. N. Bishop, Plainville.
256	Upton's Superphosphate of Lime.	George Maxwell. Rockville.
272	E. Frank Coe's Phosphate	Buck & Durkee, Willimantic.
277	" " "	Experiment Station.
273	Russell Coe's Phosphate.	Buck & Durkee, Willimantic.
275	Lombard & Matthewson's Superphosphate.	John D. Gaylord, Ashford.
295	Lombard & Matthewson's Superphosphate.	Buck & Durkee, Willimantic.
291	English Phosphate.	P. M. Augur. Middlefield.
298	Superphosphate of Lime.	M. S. Baldwin, Naugatuck.
306	Decomposed Fish and Beef Bones.	R. S. Hinman, Birmingham.
312	Americus Ammoniated Superphosphate.	D. H. Van Hoosear, E. Wilton.
318	Universal Superphosphate of Lime.	" "

Analyses, Cost and Estimated Values of Superphosphates.*

Station No.	Manufacturer or Importer.	Nitrogen.	Soluble Phos. Acid.	Revert. Phos. Acid.	Insol. Phos. Acid.	Potash.	Estim. Value per ton.	Cost per ton.	Dealer.
228	{ The Farmers' Fruit Preserving Co.,	1.68	1.98	3.66	4.77	....	$24.94	$24.00	The Farmers' Fruit Preserving Co.,
229	{ Lebanon, Delaware,	1.93	2.22	5.49	3.09	....	27.48	29.00	Lebanon, Del.
248	Booth & Edgar, N. Y.,	.32	1.10	2.12	2.29	....	11.06	20.00	Booth & Edgar, New York.
249	John J. Park, Stratford,	1.67	3.83	5.99	6.01	....	35.45	45 00	John J. Park, Stratford.
251	New Haven Chemical Co.,	2.59	4.57	1 70	3.77	7.31	36.70	38 00	New Haven Chemical Co.
271	" " "	3.01	6.32	1.37	1.57	3.18	35.37	38.00	E. W. Pierce, Plainville.
256	George Upton, Boston, Mass.,	3 08	5.49	4.58	1.13	....	35.87	30.00	C. B. Farley, assignee, Boston.
272	E. Frank Coe, Brooklyn, L. I.,	2.48	9.79	.51	1.55	....	37.49	40.00	Buck & Durkee. Willimantic.
277	" " "	2 56	8 76	2.16	1.45	....	38.06	40.00	R. B. Bradley & Co., New Haven.
278	Russell Coe, Linden, N. J.,	1.99	8.02	1.74	3.46	....	35.98	40.00	Buck and Durkee, Willimantic.
275	Lombard & Matthewson, Warrenville,	3.15	2.62	9.52	4.46	....	42 53	38.00	Lombard & Matthewson, Warrenville.
295	" " "	3.08	2.11	10.22	5.24	....	43.33	38.00	Buck & Durkee, Willimantic.
291	H. J. Baker & Bro., New York,	....	15.19	.38	1.20	....	39.50	33.00	Wilson & Burr, Middletown.
298	" " "	....	13.69	1.10	1.58	....	38.42	30.00†	H. J. Baker & Bro., New York.
306	The Earle Phosphate Co., Providence,	3.92	6.03	4.96	1.70	.60	43.97	60.00	The Earle Phosphate Co., Providence, R. I.
312	Rafferty & Williams, New York,	2.33	7.52	0.95	2.29	2.09	35.02	33.00†	Rafferty & Williams, New York.
313	" " "	2.41	5.63	.98	2.17	1.84	30.18	28.00†	" " "
	Average excluding 248, 306, 291, and 298	2.46	5.30	3.76	3.15	1.11	$35.26	$35.46	

* See page 18 and 19

† Price in New York.

The superphosphates are of three classes. Of the above samples, two, viz: **291** and **298**, are superphosphates in the original and strictly correct use of the word, i. e., they contain *soluble phosphoric acid* as their single costly ingredient.

The others are nitrogenous or ammoniated superphosphates containing, besides soluble phosphoric acid, substances of which *nitrogen* is the active element and which may yield ammonia by their decay in the soil. Of the latter, five contain a quarter or less proportion of *potash*.

The question is often asked, what are the other ingredients of a superphosphate besides those upon which its valuation is based?

This question is answered by the nearly complete analysis of **251** which follows.

NEW HAVEN CHEMICAL CO.'S AMMONIATED SUPERPHOSPHATE.

	Per cent.
Moisture,	8.05
Organic (animal) matter and combined water,	30.23
Phosphoric Acid, soluble,	4.57
Phosphoric Acid, reverted,	1.70
Phosphoric Acid, insoluble,	3.77
Sulphuric Acid,	14.12
Chlorine,	7.50
Potash,	7.31
Lime,	14.82
Magnesia,	1.37
Soda, oxide of iron and alumina by difference,	1.28
Sand and insoluble earthy matters,	5.28
	100.00
Nitrogen in organic matters,	2.59
Ammonia equivalent to nitrogen,	3.14

As to the state of the ingredients, the acids are united to the bases, lime, potash, magnesia, soda and oxide of iron, so far as the latter suffice. The soluble phosphoric acid exists as an acid salt, or, perhaps, to some extent, as free phosphoric acid. The sulphuric acid is present mainly as sulphate of lime (gypsum), the potash as muriate (potassium chloride). The reverted and insoluble phosphoric acid exist as phosphates of lime, magnesia and iron.

It is seen that a superphosphate like this, contains all those elements of plant food which are derived by vegetation from the soil, and in that sense is a "complete fertilizer."

The question might be asked, do not the lime, magnesia, sulphuric acid, etc., present in this fertilizer add to its fertilizing power and influence its agricultural value? The answer must be, yes! It then may be asked—should not the substances, which are unnamed in the usual analyses, but which are admitted to have an agricultural value, be recognized in computing the commercial value?

The answer is—the three elements which serve as the basis of the valuation, viz: nitrogen, phosphoric acid and potash, cannot be had separate from organic matters, sulphuric acid, lime, etc., and therefore the commercial value of the latter is included in that of the former. It is true that in different fertilizers, nitrogen phosphoric acid and potash are associated with different quantities, and to some extent with different kinds of other elements, but the latter are of very subordinate commercial value, and their variations do not sensibly affect the valuation of the fertilizer.

Another question often put is—why must the farmer buy so many pounds of water, organic matter, sulphate of lime, or even sand, in order to get the few pounds of valuable fertilizing matter? The answer is that the raw materials from which the manufacturer must obtain nitrogen, phosphoric acid and potash, in most cases, cannot be made to yield those valuable elements in a more concentrated state, without increased cost to the purchaser.

		Estimated Value per ton.	Cost per ton.	Value Exceeds Cost.
298	Superphosphate of Lime, Baker & Bro.,	$38.42	$30.00*	$8.42
291	English Phosphate, Baker & Bro., ..	39.50	33.00	6.50
256	Upton's Superphosphate of Lime, ...	35.87	30.00	5.87
295	Lombard & Matthewson's Superphosphate,..........................	43.33	38.00	5.33
275	Lombard & Matthewsen's Superphosphate,..........................	42.53	38.00	4.53
313	Universal Superphosphate of Lime, Rafferty & Williams, ...	30.18	28.00*	2.18
312	AmericusAmm'niat'd Superphosphate, Rafferty & Williams,............	35.02	33.00*	2.02
228	Lebanon Fertilizer, ...	24.94	24.00	.94
				Cost Exceeds Value.
251	New Haven Chem. Co.'s Ammoniated Superphosphate, ...	36.70	38.00	$1.30
229	Lebanon Fertilizer,.................	27.48	29.00	1.52
277	E. Frank Coe's Superphosphate, ...	38.06	40.00	1.94
272	" " " .	37.49	40.00	2.51
271	New Haven Chem. Co.'s Ammoniated Superphosphate,.................	35.37	38.00	2.63
278	Russell Coe's Superphosphate, ...	35.98	40.00	4.02
248	Booth & Edgar's Dissolved Bone,....	11.06	20.00	8.94
249	Stagg's Superphosphate,............	35.45	45.00	9.55
306	Earle Phosphate Co's Decomposed Fish and Beef Bones,.................	43.97	60.00	16.03

* In New York.

The table on page 24 will serve to facilitate comparison of the various samples in respect to their relative commercial value, as they are arranged in the order in which estimated value exceeds cost, or the reverse.

291 and **298** are superphosphates without nitrogen, and are believed to be of English manufacture. In them the cost of soluble phosphoric acid is $10\frac{2}{10}$ cts. per pound, making no allowance for the reverted and insoluble phosphoric acid.

The average cost of superphosphates, excluding **248, 291, 298** and **306**, which are exceptional is $35.46. The average estimated value is $35.26. That the ingredients of these fertilizers have been purchased during 1879 in other materials at less cost, will be shown on subsequent pages.

GUANOS.

Of the four articles bearing the special trade name Guano, that have been analysed, three are here reported, viz:

292 Standard Guano, Imported by Hobson, Hurtado & Co., N. Y. Sold by Wilson & Burr, Middletown. Sent by P. M. Augur, Middlefield.

283 Pine Island Guano, Manufacturers, Quinnipiac Fertilizer Co., New Haven. Dealers, G. Osborn & Tolles, Naugatuck. Sent by M. S. Baldwin, Naugatuck.

319 Manhattan Blood Guano, made by Manhattan Fertilizer Co., Bridgeport. Sold by Platt & Merwin, Milford. Sent by Jos. W. Nettleton, Milford.

Station No.	**292**	**283**	**319**
Nitrogen as Ammonia,	5.76		
Organic Nitrogen,	2.14	3.77	2.58
Soluble Phos. Acid,	5.49	1.76	5.59
Reverted Phos Acid,	3.85	2.76	3.16
Insoluble Phos. Acid,	6 33	2.25	3.37
Potash,	2.97	6.68	.96
Chlorine,		4.94	
Total Estimated value,	$66.67	$33.57	$35.67
Cost,	$58.50	$38.00	$40.00

As usual, the Peruvian Standard Guano is one of the cheapest sources of its ingredients. The Pine Island and Manhattan Guanos are manufactured articles whose mechanical condition is excellent, and they enjoy, I believe, a high reputation. Nevertheless their cost exceeds their estimated value by more than $4 per ton.

BONE MANURES.

Of the 12 fertilizers properly belonging to this class all but one are here reported. "Rotted Bone," **246**, "Dissolved Bone," **248** are elsewhere noticed, the former on p. 33, the latter on p. 21.

It is noticeable that, with two exceptions the Bone Manures cost less than the valuations. These exceptions are **279** and **305**, both of Lister Bros. manufacture. Sample **279** contained 21.6 per cent of matter soluble in cold water, probably salt cake or sulphate of soda. Sample **305** was not examined as to the quantity of salt cake present, but it is perhaps not improbable that the failure to get any good from it, which Mr. Lyman Hotchkiss states he experienced, may have been in good part owing to the salt cake which if used in large quantity or without even distribution through the soil, would easily injure vegetation, especially if applied in dry weather.

BONE MANURES.

Station Number.	Manufacturer.	Dealer.	Sent by
252	Thompson & Edwards, Chicago, Ill.	John S. Welles, Hebron.	John S. Welles, Hebron.
269	J. O. & E. Smith, Canterbury.	Charles Backus, Andover.	John S. Welles, Hebron.
279	Lister Bros., Newark, N. J.	R. B. Bradley & Co., New Haven.	Experiment Station.
305	" " "	R. B. Bradley & Co., New Haven	Lyman Hotchkiss, East Haven.
285	F. S. Johnson, Plainville.	F. S. Johnson, Plainville.	Jacob W. Hemingway, Plainville.
288	....	Royal Jennings, Agt., Trumbull.	F. G. Heublein & G. Goessinger, H'nt'gt'n
290	The Rogers & Hubbard Co., Middletown.	The Rogers & Hubbard Co., Middlet'n.	P. M. Augur, Middlefield.
293	Lombard & Matthewson, Warrenville.	Buck & Durkee, Willimantic.	Buck & Durkee, Willimantic.
294	Lombard & Matthewson, Warrenville.	Buck & Durkee, Willimantic	Buck & Durkee, Willimantic.
296	Lewis M. Wakely, Long Hill.	Lewis M. Wakely, Long Hill.	J. R. Brinsmade, Long Hill.
299	H. J. Baker & Bro., New York.	....	S. B. Wakeman, Saugatuck.

ANALYSES AND VALUATION.

Station No.	Name or Brand.	Phos. Acid.	Nitrogen.	Finer than				Coarser than 1·6 in.	Estimated Value.	Cost per ton.
				$\frac{1}{50}$ in.	$\frac{1}{25}$ in	$\frac{1}{12}$ in.	$\frac{1}{8}$ in.			
252	Chicago Bone Dust........	26.03	1.77	73	14	9	4	0	$41.45	$35.00†
269	Raw Bone, ...	20.40	4.07	10	19	21	24	26	36.94	30.00
279	Lister's Ground Bone......	10.63	2.80	45	18	15	14	[illegible]	23.10	30.00
305	" " " No. 1.	9.51	2.81	43	18	16	13	10	21 69	30.00
285	Ivory Dust	24.65	5 26	76	24	0	0	0	52.67	30.00
288	Ground Bone.............	19.46	3.85	28	25	27	19	1	37.57	32.00
290	"A" Ground Bone........	23.74	4.80	23	21	35	21	0	44.07	33.00
293	Lombard & Matthewson's Bone, No. 1.	25 13	3.77	20	43	34	3	0	45.02	36.00
294	Lombard & Matthewson's Bone, No. 2..	20.08	4.05	11	17	22	26	2	36.56	31.00
296	Pure Bone Meal, ...	21.43	4.10	32	35	28	5	0	41.84	32.00
299	Pure Ground Bone,.......	21.63	3.91	22	38	29	16	0	40 5	33.00‡

† $30 at Wholesale. ‡ $33.00 in Saugatuck, $31.50 in New York.

In my report for 1878 I proposed some changes in the mode of fixing the valuation of Bone Manures. Those changes and the reasons for them are explained in the following paragraphs quoted from that Report:

"The proper valuation of Bone Manures has, however, some difficulties. The prices customarily allowed for nitrogen are 15 cents per pound in coarse and 18 cents per pound in fine bone; the prices for phosphoric acid are 5 cents in coarse and 7 cents in fine bone. These prices are certainly not far from correct in the gross, as the agreement between average valuation ($35.50), and average cost ($33.00) demonstrates. In many individual cases, however, they are not satisfactory. The fact whether bone is fine or coarse is determined by sifting through sieves of appropriate mesh. When 50 per cent. of the bone passes holes of $\frac{1}{25}$ inch, we call the sample fine; when fifty per cent. is larger than $\frac{1}{25}$ inch, we call the sample coarse. It may thus happen that two samples, which differ but two or three per cent. in the proportion of fine bone which they contain, are valued, one at 5 and 15 cents per pound for phosphoric acid and nitrogen respectively, and the other at 7 and 18 cents. This difference in allowed price may make a difference of from $5 to $10 in the valuation, according to the quantities and proportions of phosphoric acid and nitrogen. I have, therefore, latterly adopted for medium bone the medium prices of

6 and 16½ cents for these two elements. This leaves the valuation hardly exact enough, especially since difficulty may often arise in deciding from the results of sifting to which of the three grades a sample should belong.

I therefore propose in the future (1879) to distinguish for the purposes of valuation five grades of ground bone, each with the dimensions and price below specified, viz:

Grade.	Dimensions	1879. Estimated value per pound. Nitrogen.	1879. Estimated value per pound. Phos. Acid.
Fine,	smaller than 1/50 inch,	18 cts.	7 cts.
Fine-medium,	between 1/50 and 1/25 inch,	17¼ "	6½ "
Medium,	" 1/25 and 1/12 inch,	16½ "	6 "
Coarse medium,	" 1/12 and 1/6 inch,	15¾ "	5½ "
Coarse,	larger than 1/6 inch,	15 "	5 "

The chemical and mechanical analysis of a sample of ground bone being before us, we separately compute the nitrogen value of each grade of bone which the sample contains, by multiplying the pounds of nitrogen per ton in the sample by the per cent. of each grade, taking 1/100th of that product, multiplying it by the estimated value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade, thus obtained, together with the values of each grade for phosphoric acid, similarly computed, the total is the estimated value of the sample of bone.

As an example of the valuation of a bone manure by this method the following may serve. **92,** raw bone, from Stepney Bone Mills, Monroe, contains phosphoric acid 20.56 *per cent.* or 411.2 pounds per ton, and nitrogen 3.63 *per cent.* or 72.6 pounds per ton. By the mechanical analysis it showed:

26 per cent. fine.
23 " fine medium.
27 " medium.
24 " coarse-medium.
0 " coarse.

The calculations are as follows.

72.6 × 26 ÷ 100 × 18 = $3.40
72.6 × 23 ÷ 100 × 17¼ = 2.88
72.6 × 27 ÷ 100 × 16½ = 3.23
72.6 × 24 ÷ 100 × 15¾ = 2.74
Estimated value of nitrogen = $12.25
411.2 × 26 ÷ 100 × 7 = $7.48

411.2 × 23 ÷ 100 × 6½ = 6.15
411.2 × 27 ÷ 100 × 6 = 6.66
411.2 × 24 ÷ 100 × 5½ = 5.43———
Estimated value of phosphoric acid = $25.72
Total estimated value=$37.97

This result is $1.32 higher than the valuation ($36.65) given in the table on p. 24,* and agrees within $2.00 with the cost ($40.00).

When the sample of bone contains foreign matters introduced as preservatives, dryers, or adulterants, such as salt, salt-cake, niter-cake, ground oyster-shells, spent lime, plaster, or soil, these must be taken account of in the mechanical analysis, especially since they would be likely on sifting to pass chiefly or entirely into the finer grades. Lister's Bone usually contains a considerable, sometimes a large percentage of salt-cake; of sample **101**, 54 per cent. passed the finest sieve, but the sample yields to water 14 per cent. of salt cake, which mostly passes the finest sieve. In such cases the several grades, as obtained by sifting, must be separately examined and the amounts of foreign matter which they contain must be suitably taken into the account.

In some instances a further source of error in valuation might arise from the fact that the proportions of nitrogen and phosphoric acid are not the same in the finer and coarser portions of a sample, which contains no adulterants, properly speaking, but partly consists of meat, tendon, etc., as is especially the case in certain kinds of "tankings."

There is, however, a limit beyond which it is useless to attempt to refine the processes of valuation. When they become too complicated or costly they defeat the object which they should serve. It is sufficient when the errors of valuation are no greater than those which arise from unavoidable variations in different portions of the same lot of fertilizer, or in different lots of the same brand. A difference of two or three dollars between cost and estimated value cannot ordinarily demonstrate that either is out of the way."

It is plain from the analyses made in 1879, that the estimated values for the nitrogen and phosphoric acid in bone above given and justified by the averages of 1878, are now considerably too high for the really good articles, and unless the state of the market changes, might be considerably reduced.

This fact is brought out by the following table, wherein the bone manures are arranged in the order in which their estimated value exceeds cost, or the cost exceeds estimated value.

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* Of report for 1878.

Station No.	Brand.	Estimated Value.	Cost.	Value Exceeds Cost.	Worth reckoned from average cost of 8 samples.*
285	Ivory Dust, F. S. Johnson..	$52 67	$30.00	$12.67	$42,05
290	" A " Ground Bone, Rogers & Hubbard Co.	44 07	33.00	11 07	36.41
296	Pure Bone Meal, L. M. Wakely, ...	41.84	32.00	9 84	34.64
298	Bone, No 1, Lombard & Matthewson, ..	45.02	36.00	9.02	37 55
299	Pure Ground Bone, H. J. Baker & Bro.,	40 52	33 00	7.52	33 81
269	Raw Bone, J. O. & E. Smith,...........	36.94	30 00	6.94	29 87
252	Chicago Bone Dust, Thompson & Edwards,	41.45	35.00	6.45	35.25
288	Ground Bone, R. Jennings, Agt.,........	37 57	32.00	5.57	31 15
294	Bone, No. 2, Lombard & Matthewson,...	36 56	31.00	5.56	29.64
	Average of 8 samples,*...............	40.50	32.75	7.75	33.54
				Cost Exc'ds Value.	
279	Lister's Ground Bone,.....	23 10	30 00	6 90	19.18
305	" " " No. 1,.............	21.69	35 00	8 31	17 80

* Exclusive of 285, 279 and 305.

Excluding the two samples of Lister's Ground Bone, and the Ivory Dust as exceptional, the average *cost per ton* of the other eight *bone manures* here reported is $32.75. Their average calculated value derived from the trade values adopted for 1879, p. 18, is $40.50. The average excess of estimated value over cost is therefore $7.75 per ton, or 19 per cent. of the former.

In the subjoined statement the reader may find a comparison between the estimated values adopted in 1879, for the *nitrogen and phosphoric acid* in the various grades of bone, and the actual *cost per pound* of the same in the eight samples of genuine bone analyzed at the Station during that year, the latter being, as near as may be, 18 to 20 per cent. of the former:

Grade.	Dimensions.	Estimated value per pound.		Cost per pound.	
		Nitrogen.	Phos. Acid.	Nitrogen.	Phos. Acid.
Fine,	Smaller than 1/50 inch,	18 cts	7 cts.	15 cts.	6 cts.
Fine-medium,	Between 1/50 and 1/25 inch,	17½ "	6½ "	14 "	5½ "
Medium,	" 1/25 and 1/12 inch,	16½ "	6 "	13 "	5 "
Coarse-Medium,	" 1/12 and 1/8 inch,	15¾ "	5½ "	12 "	4½ "
Coarse,	Larger than 1/8 inch,	15 "	5 "	11 "	4 "

The values given in the last column of the table on p. 30, are reckoned from these cost-figures, which are thus seen to be very nearly the real trade values of the fertilizing elements of genuine bone for the past season. The agreement between cost and the value calculated from these figures is as perfect as could be anticipated, the average value thus calculated exceeding the average cost by $0.79 per ton. As to the adoption of these reduced values in calculating the value of bone manures in the future, see further remarks on p. 55, etc.

Of the three samples which have been thrown out from this reckoning as exceptional, two, viz: **275** and **305**, have a calculated value much below their cost price. In them the bone is largely diluted with moisture and salt cake. It must be conceded, however, that the bone in these samples, having probably been boiled, might act more promptly than raw bone of equal fineness, and should therefore, perhaps, be valued at a higher rate. But this brand of Bone is very variable in composition, and must be bought at a venture, unless purchased on guarantee both as to quantity and quality of its fertilizing elements.

The other exceptional sample, ivory dust, **285**, from its extreme dryness and fineness gives a very high valuation and undoubtedly is the cheapest article among the bone manures, but it is probably not to be had in such quantity as to influence the price of ordinary bone, and from its dense texture is perhaps less active as a fertilizer than the latter.

FISH SCRAP OR FISH GUANO.

Station No.		Water.	Nitrogen.	Ammonia Equiv. to Nitrogen.	Nitrogen in water-free fish.
226	Dry Guano,	18.90	7.63	9.26	9.41
284	Dry Fish Guano,	17.64	8.13	9.87	9.87
276	Dry Ground Fish,	....	8.18	9.93	....
310	Coarse Dry Guano,	17.64	7.96	9.67	9.66
311	Fine Dry Guano,	16.01	8.11	9.85	9.65
315	Fine Dry Guano,	22.81	7.41	8.99	9.60
317	Fine Dry Fish,	22.62	7.35	8.93	9.49
320	Dry Fish Scrap,	13.70	8.19	9.95	9.47
321	Dry Fish Scrap,	16.14	7.95	9.65	9.47
328	Fish,	22.71	7.12	8.65	9.22
331	Dry Guano,	22.71	7.34	8.91	9.48
332	Dry Guano,	20.49	7.28	8.84	9.15
338	Dry Guano,	18.24	7.39	8.98	9.04
	Average for 1879,	19.13	7.70	9.34	9.46
	" " 1878,	14.90	7.65	9.24	7.91
	" " 1877,	13.66	8.24	10.01	9.36
	" " 1875 and 1876.	11.78	7.80	9.47	8.84

The thirteen samples reported were with one exception analyzed for manufacturers or private parties.

276, manufactured by the Quinnipiac Fertilizer Co., was taken by the Station from stock on sale by R. B. Bradley & Co., New Haven. It contained 6.4 per cent. of phosphoric acid. Its cost was $40 per ton. Its calculated value (nitrogen reckoned at 20 cts., phosphoric acid at 7 cts. per lb.) $41.68. The cost of phosphoric acid being reckoned at 7 cts., that of nitrogen would be 19 cts. per lb.

The names given are those furnished to the Station, and signify the same thing in various states of dryness and pulverization.

DRIED BLOOD.

Station No.		Water.	Nitrogen.	Ammonia Equiv. to Nitrogen.	Phos. Acid.
235	Dried Blood, ...	21.97	10.62	12.90	....
240	" "	....	11.78	14.30	..
250	" "	....	8.10	9.84	3.02
266	" "	....	10.71	13.00	....
267	" "	....	7.14	8.67	....
268	" "	....	7.84	9.52	....
278	" "	....	7.21	8.75	8.88
325	" "	9.93	10.83	13.15	....
336	" "	12.32	9.97	12.10	....
338	" "	15.76	10.05	12.21	....
339	" "	15.39	10.94	13.28	....
340	" "	14.16	7.90	9.59	....

With a single exception the samples of dried blood were analyzed for manufacturers.

278 is the only sample analyzed from the retail trade. It was taken by the Station from stock of R. B. Bradley & Co., New Haven, and was manufactured by S. E. Merwin & Son, New Haven. Its cost was $35 per ton. The value estimated on the basis of 20 cts. per lb. for nitrogen and 7 cts. for phosphoric acid is $41.68.

Reckoning its nitrogen at 16½ cts., and its phosphoric acid at 6½ cts., would give $35.33, or very nearly its cost price.

HAIR AND HORN.

Two samples of Hair Felt and one of Buffalo Horn Dust, all manufacturing waste, have been examined.

261 and **262** Hair Felt, sent by T. H. Ryland, Bridgeport, said to "have no market value."

286 Buffalo Horn Dust, manufactured by F. S. Johnson, Plainville. Sent by J. W. Hemingway.

Analyses.

	261	262	286
Nitrogen,	9.27	9.34	14.44
Cost of Fertilizer per ton,	?	?	$30.00
" Nitrogen per lb.,	?	?	.10½
Estimated value per ton (Nitrogen, at 15 cts.),	$27.81	$28.02	$43.32
Estimated value per ton (Nitrogen, at 11 cts.).	$20.38	$20.55	$31.77

The nitrogen of hair and of horn dust is reckoned equal in value to that of coarse bone. The value for nitrogen, hitherto adopted, viz: 15 cts. gives the horn dust a money-worth greater than its selling price by $13.32, while the cost of nitrogen in this material is 10½ cts., or nearly that of nitrogen in the coarse part of the samples of genuine bone reported on p. 26.

These articles are rich in nitrogen and contain no noticeable proportion of phosphoric acid. In use they very often prove disappointing, for the reason that their nitrogen can only become of avail to vegetation by their decay. But under ordinary circumstances they decay very slowly, and therefore remain in dry soils for a long time undecomposed. One of the simplest modes of using them is to dig them in about the roots of fruit trees, grape or hop vines, and small fruits, or to top-dress moist grass-lands. Thus applied, in considerable quantity, they make a cheap and durable source of nitrogen. To quicken their action and adapt them for general garden or farm use they should be composted with alkaline substances, such as wood ashes, "lime and salt mixture" or rich fermenting manure, the compost to be kept moist until they are thoroughly softened and impregnated with the germs of decay.

G. W. BAKER'S CHEAP ANIMAL MANURES.

244. Animal scrap manure.
245. Corena settlings.
246. Rotted bone manure.

Made by G. W. Baker, Williamsburgh, L. I.; sent March 14th, by W. J. Jennings, president Green's Farms Farmers Club.

	244	245	246
Water,	44.0	29.0	39.0
Nitrogen,	1.9	4.1	4.2
Phosphoric acid,	1.0	trace	2.8
Estimated value per ton (nitrogen at 18c., phosphoric acid at 7c.)	$6.25	$14.69	$12.41
Cost,	7.50	14.00	17.00

The above are made from materials which can scarcely furnish products of uniform quality and since the transportation in them, of a little fertilizing material, involves the carriage and handling of a large amount of water and worthless matters, they are not to be recommended for purchase unless on guarantee of composition and very favorable terms.

DAMAGED COTTON AND LINSEED MEAL.

289. Ground cotton seed, damaged. } Sampled by L. S. Wells & Son, New Britain.
297. Cotton and Linseed Pomace. Sampled by M. S. Baldwin, Naugatuck.

Both samples were sent in June and were obtained of H. J. Baker & Brother, 215 Pearl St., New York. They were apparently the same, as they agreed exactly in composition and cost.

	289	297
Nitrogen,	6.92	6.87
Phosphoric acid,	3.09	3.00
Potash,	2.06	2.10
Estimated value per ton (nitrogen at 20c, phosphoric acid at 9c. potash, 4½c.)	$35.09	$34.77
Cost per ton in New York,	18.50	18.50
" " New Britain,	22.00	
Cost per pound of Nitrogen in New Britain,	12½c.	
" " Phosphoric acid in New Britain,	6c.	
" " Potash in New Britain,	8c.	

The elements in cotton seed and linseed are shown by abundant experience to be in excellent condition for fertilizing effect, and in the above articles they were procured for some 37 per cent. less than the trade values adopted for 1879 by the Station.

HEN DUNG.

A sample received April 15th from Mr. L. H. Gager, of Quarryville, had the following composition:

	257
Moisture,	71.40
Organic matter,*	14.40
Sand and soil,	10.45
Phosphoric acid,	.45
Potash,	.49
Lime and other mineral matters,	2.81
	100.00
*With nitrogen,	.82
Estimated value per ton (nitrogen at 22c.; phosphoric acid at 9c.; potash at 6c.)	$5.01

This result of the analysis of hen manure is perhaps disappointing. We are accustomed to hear it said that the excrement of fowls is very rich, being, in fact, a domestic guano almost comparable to the guano of Peru. The poverty of this sample in fertilizing matters, stands in direct relation to the abundance of moisture and soil which it contains, amounting together to almost 82 per cent., and leaving but 18 per cent. to include all the fertilizing elements. The dry and pure dung would contain over 4 per cent. nitrogen, 2¼ per cent. phosphoric acid and 2½ per cent. potash. But these percentages are, with the exception of potash, far inferior to those of good guano, and for two reasons: 1st, the moist state of the manure has permitted a decomposition whereby nitrogen has escaped in the form of carbonate of ammonia. 2d, the food of hens, at the best, is much less rich in nitrogen and phosphates than that of the guano birds, which feed almost exclusively on fish.

The sample when it reached the Station was quite moist and exhaled ammonia decidedly, but it is not probable that decomposition had gone on far enough to cause any considerable deterioration.

SULPHATE OF AMMONIA.

The five analyses of this fertilizer were all made for manufacturers. The results are given to show the quality of the commercial article.

	227	**239**	**241**	**326**	**327**
Nitrogen,	20.09	16.35	17.39	20.26	20.22
Equivalent to Ammonia,	24.40	19.85	21.11	24.60	24.88
" " Sulphate of ammonia,	94.71	77.12	82.03	95.51	95.31

Sulphate of ammonia is cheaply manufactured as a bye product from the illuminating-gas works, and furnishes more nitrogen in a given weight than any other fertilizer employed in agriculture. Its nitrogen being in the state of ammonia, and the salt itself being freely soluble in water and entirely convenient to handle, and permanent under transport, it is eagerly bought by compounders of fertilizers. As this substance is now manufactured in the large towns of Connecticut, consumers have the opportunity to bid for the purchase of it at first hand.

POTASH SALTS.

Five samples of this class of fertilizers have been analyzed.

ANALYSES.

	263	264	265	287	302
Potash, - - - - -	37.21	27.44	48.20	59.68	32.98
Sulphuric acid, - - - - -	9.77	7.21			
Chlorine, - - - - -	36.07	37.24			
Soda, - - - - - -		12.05			
Lime, - - - - - -		1.44			
Magnesia, - - - - -		4.79			
Insoluble in water, - - - -		3.85			
Water, by difference, - - -		14.37			11.97
		108.39			
Deduct oxygen equivalent to chlorine,		8.39			
		100.00			
Potash guaranteed or implied in brand,	41.00	27.75	50.54		
Cost per ton, - - - - -	$35.00	$29.00	$35.00	$37.50	$51.20
Cost per 100 pounds of potash, - -	4.70	5.28	3.63	3.14	7.77

The above figures express the percentage of potash, sulphuric acid, etc., as found in the analyses. In case of **264** the analysis was made complete, and thus exhibits the quantities of all the ingredients present. Since, however, the metals, potassium, sodium, and magnesium are partly in combination with chlorine instead of oxygen, to state them as potash (potassium oxide) soda (sodium oxide), and magnesia (magnesium oxide), makes the footing exceed 100 by an amount of oxygen chemically equivalent to the chlorine present, which amount (8.39 per cent.), is therefore deducted. In the following statements are given the percentages of the several compounds that do or may actually exist in the samples so far as the analyses enable us to calculate them. Only in case of **264** is the analysis sufficient to make the statement complete.

	263	264	265	287	230
Sulphate of Potash, - - - -	21.27	15.90			
Muriate of Potash, - - - -	40.69	30.01	76.35	89.08	
Carbonate of Potash, - - -					48.38
Common Salt, - - - - -		26.62			
Chloride of Magnesium, - - -		11.38			
Chloride Calcium, etc., - - - -		1.92			
Water, - - - - -		14.37			
		100.00			

Reckoning all the potash in **265** and **264** as sulphate, we would have 68.80 per cent. and 47.80 per cent. of sulphate, respectively, instead of 75 per cent. and 55 per cent.

Station No.	Brand.	Importer.	Dealer.	Sent by
263	Sulphate of Potash, $75\frac{9}{10}$%* by Dr. Ulex's and Dr. Gilbert's Analyses.	New Haven Chemical Co.	New Haven Chemical Co.	J. J. Webb, Hamden.
264	Sulphate of Potash, 55%.			
265	80% Muriate.†			
287	Muriate of Potash	H. J. Baker & Co., New York City.	Wilson & Burr, Middletown.	P. M. Augur, Middlefield.
302	Salts of Potash.		H.J. Baker & Bro.	S. B. Wakeman, Saugatuck.

* Equal to 41 per cent. Potash.
† Equal to 56 per cent. Potash

Of the 37.2 per cent. of actual potash in **263** only 11.5 per cent. can exist as sulphate, while 25.7 per cent. must exist in the form of muriate. Of the 27.44 per cent. of actual potash in **264** but 8.5 per cent. can be present as sulphate and the remaining 18.95 per cent. is in the state of muriate.

We observe that the amount of potash actually existing in these samples, as received at the Station, is several per cent. (4 to 8) less than claimed by the dealer.

The dealer's guarantee is based on the analyses of the Hamburg chemists, and the deficiency may be fairly (?) attributed to absorption of moisture during or since importation.

We notice again that the samples **263** and **264**, sold as sulphate of potash, contain less than one-third of their potash as sulphate, and more than two thirds as muriate.

Sulphate of potash is therefore a trade name, and, like many other trade names, involves a fiction more to the advantage of the seller than of the purchaser. The notion is prevalent that sulphate of potash is a better fertilizer than muriate of potash. Some experiments have been published going to show that potatoes and tobacco raised with sulphate are of better quality than when raised with muriate. Whether this be the fact generally, may well be doubted. Nevertheless the idea is stoutly upheld that sulphate of potash is worth more than muriate for fertilizing purposes, and advantage is taken of the superiority, real or fancied, to sell as sulphate an article that is no better than muriate. In fact both of these samples of so-called "sulphate" contain more chlorine than enough to make a muriate of all the potash they contain! The advantage of sulphate of potash as a fertilizer lies, if anywhere, in the *absence of chlorine compounds*, which are supposed to injure the qualitity of certain crops, but as the chlorine compounds (muriate of potash and common salt) are present in these so-called sulphates, in no less quantity, than in a pure muriate, they cannot be expected to make better potatoes or a better tobacco than the latter.

We see, finally, that the cost of potash in the high grade muriate is considerably less than in the so-called "sulphates," evidently, therefore, muriate of potash is the cheapest source of potash. The common salt, chloride of magnesium and water which makes up more than half of **264**, and more than one-third of **263**, have no commercial or agricultural value corresponding to their cost.

Genuine high grade sulphate of potash can be had, but its cost is considerably greater than that of these more than half spurious sulphates. Sulphate of 80 per cent. containing 43 per cent. actual potash, has been recently reported to cost $75 per ton, or 8¾cts. per pound of actual potash.

302 is an impure carbonate of potash containing some prussiate—evidently a manufacturing bye-product. The sample was kept for some weeks in an imperfectly closed tin can and had gathered some moisture from the air. Some allowance should be made for that fact in considering the cost of its potash, but how much cannot be stated. Carbonate of potash is corrosive and would be likely to injure vegetation if incautiously used. It is easily distinguished from sulphate and muriate by its effervescence when drenched with vinegar or other acid. Carbonate of potash shares with sulphate of potash any advantage which the latter may have over muriate as a tobacco fertilizer.

OYSTER SHELL LIME.

The three accompanying analyses exhibit the composition of samples of oyster shell lime and screenings made by H. A. Barnes & Co., Fair Haven. The samples were taken on Nov. 24th, 1879, by Dr. Armsby, with the assistance of Mr. Barnes, who has also supplied the following data descriptive of the samples.

328 is unscreened oyster shell lime, slacked the day the sample was drawn.

329 is unscreened oyster shell lime, slacked, and about six months old.

330 is oyster shell lime screenings.

The two samples of slacked lime are fine and in good condition to apply to land, **328** being quite dry in handling, **329** damp and coherent.

The slacked and unscreened lime which these two samples represent is sold by measure and not by weight. The price, in November, 1879, was 8 cts. per bushel at the works, and 9½ cts. per car load, shipped in bulk at R. R. Depot. The average weight of the screened slacked lime used for building purposes is stated to be 47 pounds per bushel. As the screenings amount to 3 to 5 per cent. of the total, it is not far from the truth to assume that the unscreened will weigh 50 pounds per bushel. The cost of this lime would be accordingly 16 cents per 100 pounds, at the kilns, or $3.20 per ton. Shipped in casks holding 16 to 25 bushels, the lime costs about 1½ cents more per bushel and the casks cost $1.00 each, which would bring the cost of a ton up to about $6.40, two casks included.

The screenings, **330**, consist largely of imperfectly burned shells, entire or in fragments. They are not shipped but are sold at the kilns for 4 to 6 cents per bushel.

The unslacked lime, of which we have no analysis, is stated to weigh on the average 70 pounds per bushel, and is sold in bulk at the R. R. Depot, for 17 cents per bushel or about 24 cents per 100 pounds, or $4.80 per ton. Shipped in casks, its price is 19 cents per bushel, the casks costing $1.00 each, which would make the ton cost $7.70.

Analyses of Oyster Shell Lime and Screenings.

	328	329	330
Lime,	64.47	53.60	53 82
Magnesia,	.41	.32	.24
Oxide of Iron and Alumina,	1.50	1.43	1.14
Soda,	.16	.27	.15
Potash,	.04	.06	.03
Carbonic acid,	7.79	8.89	22.34
Sulphuric acid,	.52	.69	.23
Chlorine	.04	.02	.01
Phosphoric acid,	.17	.19	.15
Silica,	2.24	2.41	6.12
Sand,	5.08	2.85	
Coal,	.65	.94	2.60
Water (by difference)	16.93	28.33	13.17
	100.00	100.00	100.00

In the subjoined statement are given the proportions of the various chemical compounds that probably exist in the samples.

	328	329	330
Carbonate of lime,	17.45	19.73	50.52
Hydrate of lime,	68.74	52.34	33.29
Sulphate of lime,	1.12	1.48	.49
Phosphate of lime,	.37	.41	.33
Silicate of lime,*	4.33	4.66	.—
Magnesia,	.41	.32	.24
Carbonate of potash,	.06	.09	.04
Carbonate of soda,	.22	.43	.24
Sodium chloride (common salt),	.07	.03	.02
Oxide of iron, and alumina,	1.50	1.43	1.14
Silica,	—	—	6.12
Sand,	5.08	2.85	
Coal,	.65	.94	2.60
Water,	.00	15.29	4.97
	100.00	100.00	100.00

*Soluble silica is calculated as silicate of lime, $CaSiO_3$. In **330** silica was not separately determined and the lime, possibly existing as silicate in it is reckoned as hydrate.

On referring to the results of these analyses we notice that the two samples of lime contain about 9 per cent. of sand and coal or of substances mostly derived from them, viz: oxide of iron, alumina, and silica. We have small quantities of potash, soda, magnesia, phosphoric and sulphuric acids, altogether amounting to 1.5 per cent. Both samples contain also nearly equal quantities of carbonic acid, viz: 8.3 per cent. Lime, the chief ingredient, varies from 64.5 to 53.6, or nearly 11 per cent., and water from 17 to over 28, also 11 per cent.

Looking now to the statement of the proportions of the compounds probably existing in the samples, we see that in the two samples of slacked lime the chief ingredient is hydrate of lime (or calcium hydroxide), next to this in quantity comes carbonate of lime (or calcium carbonate), followed by silicate of lime 4.05 per cent., sulphate 1.03 per cent., and phosphate 0.4 per cent.

A brief review of the chemistry of the lime manufacture may be serviceable. Clean oyster shells consist chiefly of carbonate of lime. As they are used in lime manufacture they contain probably about 7 per cent. moisture and organic matter, about 6 of soil and sand, and 87 per cent. of carbonate of lime. In passing through the kiln the carbonic acid is mostly expelled. If completely expelled the loss would be 38 pounds of carbonic acid for 100 pounds of shells, leaving 49 pounds of quick lime (calcium oxide). With this would of course remain the sand, mud, etc., that originally adhered to the shells, together with the ashes of the coal used in burning. The lime thus obtained is slacked by throwing on water, in order to reduce it to a powder. In this process of slacking, water and lime enter into chemical combination, the 49 parts of lime becoming 64 parts of hydrate of lime. In practice some carbonate of lime remains undecomposed by the burning, and in the slacking process, the use of insufficient water may leave some quick lime unconverted into hydrate, or excess of water may remain as moisture, as is the case with sample **329.**

When applied to land, oyster-shell lime may act as a *fertilizer* strictly speaking, or as an *amendment.* Commonly, both kinds of action are exerted, and the distinction between fertilizer and amendment is not generally recognized in practice although very important in considering the effects of this substance. Lime is used as an amendment on heavy clay soils, 2 to 3 or more tons being sometimes applied per acre. On loams or light lands 1,000 pounds or 20 bushels of oyster shell lime, applied once in two or three years, is a usual application, equivalent to the addition of 300 to 500 pounds to the acre, annually. It is evident that the small quantities of potash, magnesia and phosphoric acid contained in such doses of oyster shell lime can have no sensible effect upon crops. It is the lime, alone therefore, to which any benefit must be ascribed. A consideration of the modes of action of hydrate of lime, when applied as a fertilizer, will make evident that it is one of the most valuable aids to the farmer and deserves more attention from Connecticut land owners than it has received.

Our cultivated crops contain on the average as much lime as potash. The necessity for the application of potash salts is fully recognized, but probably the lack of lime is as common a cause of unfruitfulness; for while potash seldom wastes from the soil to any serious extent, and is found in spring, well, and river waters in extremely small quantities, lime freely dissolves in water and rapidly wastes from the soil, so that other things being equal there is more need for its restoration.

PAPER MILL WASTE, CHARTER OAK FERTILIZER.

243. Paper mill waste. Sent March, 7th, by R. E. Pinney, Suffield.

270. Charter Oak fertilizer. Made by Charter Oak Paper Co., Parkville. Sampled and sent, April, 29th, by Paul Thomson, West Hartford.

Since the basis of the Charter Oak fertilizer is evidently the refuse lime of a paper mill to which small quantities of phosphoric acid and nitrogen have been added, its analysis is placed here in comparison with that of **243.** In Bulletin 21 a partial analysis of the latter was reported, which differs somewhat from the more complete and correct analysis here given. The difference is due in part to the difficulty of getting an average of the pasty mass, and in part to the absorption of carbonic acid from the air during the slow drying of the sample, which led to overstating the carbonate and understating the hydrate of lime.

Analyses.

	243	270
Lime,	30.15	30.91
Magnesia,	.28	11.76
Oxide of iron, and alumina,	.61	——
Soda,	2.87	.24
Potash,	——	.30
Sulphuric acid,	.61	.95
Carbonic acid,	13.52	10.47
Phosphoric acid,	trace	1.02
Chlorine,	.24	.18
Moisture,	43.09	24.34
Insoluble residue and silica,	1.68	3.49
Combined water and organic matter,*	6.95	16.39
	100.00	100.00
*Containing nitrogen,	none	.47

Reckoning the acids and bases into the chemical compounds likely to exist in these fertilizers we have the following statement:

	243	270
Carbonate of lime,	26.43	23.80
Hydrate of lime,	19.70	20.76
Sulphate of lime (hydrated),	1.31	2.04
Phosphate of lime,	——	2.28
Hydrate of magnesia,	.41	17.05
Carbonate of potash,	——	.44
Carbonate of soda,	4.56	.22
Sodium chloride,	.39	.21
Sand and silica,	1.68	3.49
Moisture,	42.50	23.00
Oxide of iron, and alumina	.61	6.76
Organic matter,	2.41	
	100.00	100.00

It thus appears that this paper-mill refuse consists essentially of a mixture of carbonate and hydrate of lime. It contains also carbonate of soda and carbonate of potash in varying quantity and **270** contains 17 per cent. of hydrate of magnesia, evidently derived from the magnesian limestone used in the kilns of North-Western Connecticut. As a fertilizer the simple paper mill waste in its wet state is equal in commercial and fertilizing value to about half its weight of dry slaked oyster shell lime, or $3.20 per ton.*

The Charter Oak fertilizer, **270**, is worth for its lime and magnesia, not more than $3.50 per ton. Its phosphoric acid, potash and nitrogen at the most liberal estimate are worth $4.00 per ton, making its total commercial value about $7.50 per ton or one half the selling price.

SHELL MARL.

324. Received from Mr. Nathan Hart, West Cornwall, Oct. 22d.

Moisture,	23.72
Silica, sand and insoluble matter,	16.88
Oxide of iron and alumina,	1.55
Lime,	27.99
Magnesia,	.97
Soda,	.59
Potash,	trace.
Sulphuric acid,	.46
Phosphoric acid,	trace.
Carbonic acid,	21.77
Organic matter,* by difference,	5.87
	100.00
*Containing organic nitrogen,	0.44

This shell marl consists of *carbonate of lime* to the extent of 40 per cent. and contains 2 per cent. of *carbonate of magnesia*, also 0.9 per cent. of sulphate of soda, and 0.25 per cent. of carbonate of soda. The organic matter includes nearly 0.5 per cent. of nitrogen, in organic combination.

Mr. Hart informed the Station, that parties, whose names were not given, proposed to put this marl on the market as a fertilizer at the price of $15 per ton.

There can be no doubt that its employment, in liberal quantities, viz: one or more tons per acre, especially upon grass lands, would often be attended with decided and long-continued benefit but, in most cases, its action upon grain crops would not appear at once in so decided a manner as is very commonly the case with good superphosphates or guanos.

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* Compared with the slacked oyster shell lime, *shipped in casks*, or $1.60 compared with lime in bulk at kilns.

The fertilizing effects of this shell marl as well as its commercial value may be safely measured by the per centage of lime which it contains. Its effects on crops would be in general quite similar to those of oyster shell lime although somewhat less pronounced since carbonate is a less energetic agent than hydrate of lime. Its content of lime, 28 per cent., is less than one-half as much as that of the two samples of slacked unscreened oyster shell lime described on a previous page, whose average is 59 per cent. As 1,000 pounds of the latter costs at New Haven, shipped in casks, $3.20, it is evident that the proposed price of the marl, $15 per ton, is much too large, even after making the most liberal allowance for cost of handling.

Leached Wood Ashes.

	307	308	309
Sent by	Moses Sherwood, Greens Farms,	Moses Sherwood, Greens Farms,	Henry Baldwin, Canterbury.
Dealer,	N. Alvord, Greens Farms,	D. Thorp, Greens Farms,	James A. Bill, Lyme.
Weight per bush.,	56 lbs.	54 lbs.	58 lbs.
Cost " "	12½ cts.	14 cts.	16½ cts.
Cost per 100 lbs.,	22 "	26 "	28 "

Analyses.

	307	308	309
Potash,	1.00	1.29	1.04
Soda,	.61	.53	.62
Lime,	29.83	33.59	28.71
Magnesia,	3.22	3.07	2.61
Iron oxide,	1.43	2.60	1.46
Phosphoric Acid,	1.30	2.02	1.55
Sulphuric Acid,	.13	.13	.13
Chlorine,	trace.	trace.	trace.
Silica and Insoluble,	9.82	5.76	7.65
Char,	1.96	3.06	1.48
Water	26.88	24.05	33.99
Carbonic Acid and Loss,	23.82	23.90	20.76
	100.00	100.00	100.00
Carbonate of Lime equivalent to Lime,	53.2	60.0	51.2

These samples agree closely in composition with those reported last year. They are somewhat drier and contain rather more potash and phosphoric acid.

These ashes applied at the rate of a ton (36 bushels) per acre, furnish, besides a large dose of carbonate of lime (1100 lbs.), serviceable quantities of potash (20 lbs.), of magnesia (60 lbs.), and of phosphoric acid (30 lbs); but the chief effects of the application come from the carbonate of lime. In my Report for 1878 I gave suggestions for preparing a substitute for leached ashes. With help of the analyses of oyster-shell lime, previously given, we can calculate still more closely the composition and cost of a mixture which would be equal in all respects, or even superior to these leached ashes here reported. The fertilizing matters of 100 lbs. of the leached ashes would be contained in

Slacked Oyster-Shell Lime, ...	54 lbs.	costing*,	9 cts.
Muriate of Potash, ...	2 "	"	7 "
Ground Bone, ...	8 "	"	12 "
	Total, ...		28 cts.

* At kiln.

100 lbs. of leached ashes cost on the average 25 cts. Our mixture, however, would contain, in its bone, about four cents worth of nitrogen which is absent from leached ashes, so that the cost of the materials of this mixture is not greater than that of the ashes. The mixture would contain hydrate of lime which would make it in most cases a better application to the soil, but might perhaps do damage to the plant unless carefully distributed.

UNLEACHED WOOD ASHES.

The following analyses were made on samples of house ashes prepared in a stove, and kindly supplied by G. H. Glover, Esq., North Branford. They illustrate the variability of wood ashes in respect to potash, &c. The quantity of sand is unusually large.

	Chestnut 258	Oak. 254	Hickory. 255
Potash, ...	3.07	9.37	4.56
Soda, ...	.42	1.92	.53
Lime, ...	29.15	29.65	36.29
Magnesia, ...	9.63	3.65	5.71
Iron Oxide, ...	5.21	3.73	2.79
Phosphoric Acid, ...	2.51	2.42	1.63
Sulphuric Acid, ...	2.46	1.88	.99
Chlorine, ...	.17	1.49	.19
Carbonic Acid, ...	12.80	16.57	23.22
Sand and Silica, ...	26.70	22.07	18.09
Char, ...	3.26	1.97	1.51
Water and Loss, ...	4.62	5.28	4.49
	100.0	100.0	100.0

NEW JERSEY GREEN MARL.

316, shipped by the Kirkwood Marl and Fertilizing Co , Kirkwood, N. J. Dealer, Paul Thomson, West Hartford. Sample received from Paul Thomson, Aug. 25. Price at Hartford $4.00 per ton.

Analyses.

	316	By N. J. geologist.
Moisture,	16.70	9.66
Combined water,	3.26	
Sand (insoluble silica),	18.33	50.80
Silica, soluble,	26.65	
Oxides of Iron,	23.00	17.63
Alumina,		8.77
Lime,	.43	2.13
Magnesia,	3.12	3.54
Potash,	5.69	5.18
Soda,	.60	....
Phosphoric acid,	.90	2.24
Sulphuric acid,	.42	.39
Other matters, undetermined,		....
	100.00	100.34

The Green Sand Marl has long been a staple fertilizer and amendment in the State of New Jersey, where it occurs as a geological deposit or rather as three distinct deposits, (upper, middle and lower marl beds) which stretch across the State from the Highlands of Navesink near Sandy Hook to the Delaware river below Wilmington, and in many localities admits of easy excavation. In composition it is somewhat variable as shown by the analyses above given, made on separate samples which were obtained quite near each other. If the value of the potash and phosphoric acid in the above analysis is reckoned, for the former, at its lowest price, viz., 4½ cts. per lb., and for the latter at 9 cts. per lb., the value of the reverted phos. acid, we have in 2,000 lbs. of **316,** no less than 114 lbs. of potash worth $5.13 and 18 lbs. of phos. acid worth $1.62, the total being $6.75. The same reckoning applied to the other analysis, which is published by Prof. Cook in the Annual Report of the State Geologist of New Jersey for 1878, p. 45, gives 103.6 lbs. potash worth $4.66 and 45 lbs. phos. acid worth $4.03, the total being $8.69 as the worth of a ton.

It must be conceded, however, that the green marl contains its potash not in the freely soluble state of muriate or sulphate, but as a less soluble silicate, not worth commercially so much as the potash of potash-salts. Experience shows, nevertheless, that vegetation makes ready use of the plant-food contained in the marl, its application having a speedy effect on clover and grass.

The silicate of alumina, iron and potash which constitutes the green sand (or *glauconite*, as the pure green mineral is termed by geologists), in fact readily suffers decomposition with liberation of its potash, and at the same time furnishes in the residual silicate, the substance which confers on good soils their remarkable quality of retaining the soluble fertilizing elements which would otherwise go to waste. No doubt it is this silicate which largely accounts for the striking improvement of the light sandy soils of Eastern New Jersey, large tracts of which have been transformed from a desert to a garden, mainly as a consequence of the use of this marl.

At the price charged, the green sand marl will be found, to judge from the results of its use in New Jersey, a cheap means of improving not only our very light soils, but also the better loams which require constant manuring to maintain their fertility.

This marl must usually be applied in large quantities, several tons to the acre, in order to get good results. It then forms a valuable amendment and a durable source of potash.

MARINE MUD AND SEA WEED.

A sample of black mud containing some seaweed from salt-water at Saybrook, was sent to the the Station by Geo. M. Denison, Esq., who states that it is exposed at low tide, and can be got upon the land for about 25 cents per load.

	327
Water,	71.32
*Organic and Volatile matters,	2.79
Sand, Clay and substances insoluble in acid,	20.82
†Oxide of Iron and Alumina,	2.62
Lime,	.26
Magnesia,	.51
Soda,	.60
Potash,	.17
Chlorine,	.51
Sulphuric Acid,	.39
Phosphoric Acid,	trace.

* Contains Nitrogen, 0.14 per cent.

† Most of the Iron exists as protoxide.

This mud contains, in fertilizing elements, the small amount of *nitrogen*, *lime*, *magnesia*, *soda*, *potash*, *chlorine*, and *sulphuric acid* given in the analysis, altogether amounting to about 2½ per cent of the total. But stable manure—the standard fertilizer—contains but about the same amount of plant-food, and of the same kinds, except that it has less sulphuric and more phosphoric acid, less soda and more potash.

The mud, when used judiciously, will prove an excellent fertilizer. Doubtless other samples might contain more phosphates. In any case, the mud, used copiously, together with fish, which are rich in nitrogen and phosphates, and with seaweed, which contains abundant potash, will supply all the plant-food that crops require, and serve to maintain or increase fertility of the soil to the fullest degree.

The only drawback to the use of the marine mud lies in the considerable proportion of soluble salts, mostly common salt, which it contains, being nearly one per cent. If thrown out in heaps and exposed to the rain this salt will be mostly removed. The mud may also be applied directly to root crops or grass in moderate quantities without damage, if well distributed.

As an *amendment* the fine mud must have an excellent effect on coarse-textured soils.

FRESH WATER SEDIMENTS.

	314 East Wilton.	**322** Essex.	**334** Woodstock.
Moisture,	34.44	5.75	4.77
*Organic and Volatile matters,	2.78	8.11*	7.81*
Oxides of Iron and Alumina,	3.58	5.69	3.10
Lime,		.67	trace
Magnesia,		.88	trace
Potash,		.18	none
Soda,		.06	.05
Phosphoric Acid,		.16	trace
Sulphuric Acid,		.46	.06
Sand, Silica, &c., insoluble in acid,	59.20	78.04	84.71
	100.00	100.00	100.00
*Containing Nitrogen,		0.29	0.15

314 was sent by D. H. Van Hoosear, Secretary East Wilton Farmers Club, in August last, described as "deposit from the bottom of a pond hole." The partial analysis showed such large proportions of water and insoluble matters as to lead to the conclusion that the deposit would have little more value as a fertilizer than a good soil.

The sample **322** whose analysis is next given was sent, labeled dried mud, by Mr. J. I. Stevens, of Essex, who states that "its effect as a top dressing for lawns and also on mowing land has proved greater for good than anything I have ever seen. On many crops it has given me better results than $45 crop foods I have purchased. This mud is under water the year round."

The analysis agrees remarkably with that of pond mud from North Woodstock, mentioned in the Report for 1877. It contains, however, a little more phosphates and sulphates. In reply to Mr. Stevens' inquiries, was written as follows:

"The dried mud contains every element of plant food in about the proportions that are usually present in stable manure, or in good composts. Like the fertilizers just named it contains but about 3 per cent. of immediately available plant food; the other 97 per cent. being water, sand, or clay, vegetable matters, oxides of iron and alumina, not differing in character or fertilizing value so far as is known from the same substances as they make up the bulk of ordinary soils. Unlike stable manure and ordinary composts the mud contains a considerable amount of sulphuric acid in the form of sulphate of lime. The mud contains 0.46 per cent. of sulphuric acid, while stable manure has but 0.10 per cent. or less. It is quite likely that this fact may have made the mud so useful in your experience."

Doubtless a pretty liberal application of the mud would be required to produce the striking results Mr. Stevens observed.

In a recent note Mr. Stevens states that the mud sent by him was from a cove or pocket from the Connecticut River; the sediment is brought down in the spring freshets by the Connecticut, the cove being connected with the river by a narrow channel. There is no current in it and suspended matters are deposited at such a rate as to have reduced the depth of the water three feet since the remembrance of elderly people. There is but little matter washed in from the surrounding hills. The river at this point contains salt from the setting back of the tide during only from 4 to 6 weeks annually. Some entire years there is no salt at all in the river at this point. The quality of the sample sent was not up to the average. It should have been taken from the middle of the cove.

Mr. Stevens also remarks: "Our mill ponds a few miles back from the river, contain a rich, black mud, quite deep and with a very strong smell. It has been tried on various crops but kills everything. After being hauled and dried it turns from black to white, and puckers the mouth like alum."

The astringency here referred to is due to soluble salts of iron or alumina. Composting with a small proportion of slacked lime will decompose these salts and render the black mud a safe and serviceable application.

Sample **334** received from S. Palmer, Woodstock, consists almost entirely of sand and silica with the merest traces of fertilizing elements. Much of the silica exists in the form of the skeletons or shields of microscopic infusorial plants which are common in the water of swamps and bogs. From its light gray color it might be mistaken for marl such as sample **324**, but on mixing with acids, like vinegar, it effervesces very slightly, containing but a trace of carbonate of lime.

PEAT OR SWAMP MUCK.

Three samples sent by G. M. Dennison, Esq., of New London, are from the town of Old Saybrook.

335 and **341** from the farm of Mr. Dennison, **342** is traversed by the Connecticut Valley Railroad, near Mr. Dennison's land.

	335	**341**	**342**
Moisture,	85.25	81.40	87.22
*Organic and volatile matter,	12.52	12.49	10.42
Ash,	2.23	6.11	2.36
	100.00	100.00	100.00
Containing nitrogen,	.43	.42	.27

Reckoned in the dry state the composition is as follows:

	335	**341**	**342**
Organic and volatile,	84.87	67.08	81.53
Ash,	15.13	32.92	18.47
	100.00	100.00	100.00
Nitrogen,	2.91	2.24	2.11

The dry swamp muck is thus seen to contain 2 to 3 per cent. of nitrogen which under the action of an alkali like lime, or ammonia may become available as plant food. The organic matter itself under favorable conditions serves to liberate lime, potash, &c., from the mineral matters of the soil.

There can be no doubt that the application of this swamp muck, especially to poor, light soils, would be very serviceable. Evidently, however, the large proportion of water which the fresh muck contains makes it a nice point to decide how much can be spent upon its handling without consuming the profit of its application. The proper mode of using swamp muck is to throw it out where it will drain and dry for some months, during frosty weather, and to employ the weathered muck as an absorbent in the stables or barn yard, or to compost it with lime, fish or animal matters yielding ammonia by their decomposition.

CATCH BASIN SEDIMENTS.

Two samples from the New Haven sewers sent by Prof. W. H. Brewer, after becoming air dry, or nearly so, were submitted to partial analysis with the following results:

	280	**281**
Moisture,	.64	7.04
*Organic and Volatile Matters,	9.29	34.52
Sand and soil,	90.07	58.44
	100.00	10.000
Containing Nitrogen,		0.42

SPECIAL MANURES OR FORMULAS FOR PARTICULAR CROPS.

The idea that a fertilizer can be compounded which will ensure or be specially adapted to each particular crop which the farmer has occasion to produce, is a very taking one, and it is not surprising that the farmer should seek refuge from the uncertainties which environ him, by the use of fertilizers which claim to be so scientifically compounded that the chance of failure in getting a crop is reduced to the very lowest possible limit.

In the Report for 1878, some account of the history of special fertilizers and the principles on which they are compounded has been given. It is claimed, for instance, that the onion fertilizer contains the elements which must be added to the soil in order to produce a good crop of onions, and that the proportions in which they are mixed are those which the onion crop specially requires. When we have three distinct onion fertilizers, all of which make the same claim, and which differ widely from each other in the forms in which their fertilizing ingredients are present, as well as in the proportion of those ingredients, we have reason to believe that neither science nor practice has reached such a stage of intelligence as to be able to compound a fertilizer which deserves to be called an "onion fertilizer" because it is particularly adapted for onions rather than for any other crop. Such is, indeed, the fact, and the so-called "special fertilizers" may or may not be adapted to the crop whose name they bear, in general or in any particular case; may or may not be good fertilizers for common purposes; may or may not be worth commercially the money they cost.

Special Fertilizers.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Sent by
258	Stockbridge Onion Fertilizer, ...	W. H. Bowker & Co.	Hubbell & Wakeman, Saugatuck.	T. B. Wakeman, Greens Farms.
259	Mapes Onion "	The Mapes Formula and Peruvian Guano Co., New York.	Manufacturers,	" "
301	Forrester's Onion "	H. J. Baker & Bro., N. Y.	"	S. B. Wakeman, Saugatuck.
260	Stockbridge Potato "	W. H. Bowker & Co.	Hubbell & Wakeman, Saugatuck.	T. B. Wakeman, Greens Farms.
282	Forrester's Potato "	H. J. Baker & Bro.	Manufacturers.	M. S. Baldwin, Naugatuck.
304	" Potato "	H. J. Baker & Bro., N. Y.	"	S. B. Wakeman, Saugatuck.
281	" Cabbage "	H. J. Baker & Bro., N. Y.	"	M. S. Baldwin, Naugatuck.
284	" Strawberry "	H. J. Baker & Bro., N. Y.	"	" "
300	" Corn "	H. J. Baker & Bro., N. Y.	"	S. B. Wakeman, Saugatuck.
303	" Turnip "	H. J. Baker & Bro., N. Y.	"	" "
274	Stockbridge Tobacco "	W. H. Bowker & Co.	"	Chas. Sanford, Roxbury.
280	" Grass Top Dressing,..	" "	R. B. Bradley & Co., New Haven.	Experiment Station.

SPECIAL FERTILIZERS.

Analyses.

Station No.	Nitrogen as Ammonia.	Nitrogen as Nitrates.	Organic Nitrogen.	Total Nitrogen.	Soluble Phos. Acid.	Reverted Phos. Acid.	Insol. Phos. Acid.	Potash.	Chlorine.	Estim. Value per ton.	Cost per ton.
258	....	....	3.91	3.91	5.78	.68	.13	8.32	13.99	$38.77	$50.00
259	3.19	....	2.51	5.70	2.05	4.15	2.53	7.47	8.44	47.26	50.00
301	5.45	....	1.91	7.36	1.78	2.76	.35	7.39	1.76	53.05	50.00
260	....	...	3.82	3.82	6.10	.92	.19	8.84	7.49	40.42	50.00
282	3.90	....	.72	4.62	.37	5.09	1.63	9.06	2.66	46.39	47.50
304	3.89	....	.88	4.77	.24	5.08	1.79	10.31	2.82	54.15	50.00
281	5.99	....	.28	6.27	3.85	2.21	.45	7.44	2.03	53.44	50.00
284	2.41	....	.60	3.01	8.22	2.12	.85	5.91	2.10	47.60	42.50
304	5.52	....	....	5.52	.44	4.86	1.46	13.09	3.53	56.37	50.00
308	6.73	....	1.18	7.91	.67	3.53	.29	8.30	2.60	59.54	53.50
274	2.85	....	2.85	5.70	.72	.71	.27	7.36	1.34	38.73	50.00
280	2.14	2.79	1.17	6.10	3.79	.30	.36	7.52	7.51	46.10	50.00
								Average,	....	48.40	49.46

The designations they bear must, therefore, be regarded as simply trade names. The full records of the results of their use would demonstrate that they fail as often as they succeed upon the crops for which they are specially designed, and that the tobacco fertilizer can be used upon the potato crop, and the corn fertilizer upon onions with as good results, in the average of a thousand cases, as if applied to the crops whose names they carry.

We observe that the three onion fertilizers in the accompanying table of analyses contain respectively 3.9, 5.7, 7.4 per cent. of nitrogen; 6.5, 8.7, 4.8 per cent. of phosphoric acid, and 8.3, 7.5, 7.4, per cent. of potash. Their estimated values are $38.77, $47.26, and $53.05 per ton. Their cost, however, is alike, namely $50 per ton in each case. Contrast with these differences the resemblance between the Stockbridge onion and the Stockbridge potato fertilizer. They contain respectively, of nitrogen 3.9 and 3.8 per cent., of phosphoric acid 6.5 and 7.2 per cent., of potash 8.3 and 8.8 per cent. If we compare the analyses above given with those reported last year, we shall see that the manufacturers do not confine themselves very strictly to their formulas, which is a significant indication of the value they attach to them.

As to the commercial value of these fertilizers we find their average cost exceeds their valuation but $1.00 per ton. We notice, however, that the value of some of them falls considerably below their cost. The following table will be useful for comparison:

		Valuation.	Cost.	Cost Exceeds Valuation.
274	Stockbridge Tobacco,	$38.73	$50.00	$11.27
258	" Onion,	38.77	50.00	11.23
260	" Potato,	40.42	50.00	9.58
280	" Grass Top Dressing,	46.10	50.00	3.90
259	Mapes Onion,	47.26	50.00	2.74
282	Forrester's Potato,	46.39	47.50	1.11
				Valuation Exceeds Cost.
301	Forrester's Onion,	53.05	50.00	$3.05
281	" Cabbage,	53.44	50.00	3.44
304	" Potato,	54.15	50.00	4.15
284	" Strawberry,	47.60	42.50	5.10
303	" Turnip,	59.54	53.50	6.04
300	" Corn,	56.37	50.00	6.37

COST OF ACTIVE INGREDIENTS OF FERTILIZERS DURING 1879.

*Organic Nitrogen.**—Fish scrap, dried blood, dried meat and tankings (the latter sometimes termed azotine) are produced in immense quantities and consumed for fertilizing purposes. They do not, however, pass to any considerable extent directly into the hands of farmers, and are not largely applied to the land in the state in which they are first produced, but they are mostly sold from the Menhaden works and slaughter houses to the compounders of superphosphates and other artificial fertilizers, where they are used to supply nitrogen to these articles, being mixed with various phosphates treated with oil of vitriol, with potash salts, etc.

The first wholesale cost of organic nitrogen is but a little more than one-half what the Station valuation allows as the fair retail price. Fish scraps, dried blood, meat and tankings are sold at wholesale at so much per "unit of ammonia," without regard to the phosphoric acid, which in dried fish amounts to 6–7 per cent. and in blood, meat, etc., ranges from less than 1 up to 10 per cent., according as more or less bone happens to be included. During the past summer the unit of ammonia† in fish, blood, etc., has been worth in New York but from $2.30 to $2.60. At $2.50 per unit of ammonia, the wholesale price of nitrogen would be 10½ cts. per pound, with, in general, several per cent. of phosphoric acid thrown in.

Now what justifies the Station in valuing this same nitrogen when it comes into our retail markets at 20 cents per pound and at the same time allowing several cents per pound for the accompanying phosphoric acid?

The Station only can answer that the retail market justifies the trade values it employs, and would, so far as many of the superphosphates and all the guanos, other than Peruvian, are concerned, justify trade values higher than it has employed.

The difference between the wholesale and retail cost of organic nitrogen is made up by various items of expense, viz: transportation; grinding and mixing with the phosphates or potash salts; bagging or barreling, storage and transportation of the superphosphate; commission to agents and dealers; losses due to sales on long credit, interest on investment, and finally profits.

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* Or "potential ammonia."

† That is 20 pounds per ton for the nitrogen reckoned as ammonia, 14 pounds of nitrogen being equal to 17 pounds of ammonia.

A large expense is incurred by the makers of superphosphates in the fact that from the date their raw materials are purchased up to the time of getting pay for the finished article, six, nine or even twelve months elapse and, of necessity, the capital thus employed must draw interest from the final purchasers for whose benefit it is employed.

It is worthy the attention of consumers of fertilizers to carefully consider whether a part of these expenses may not be saved with advantage to themselves and to the manufacturers.

Many forehanded farmers are in the habit of getting their fertilizers at much less than the usual retail prices. This is done simply by making use of their knowledge of the details involved in the business of manufacturing fertilizers, a knowledge which they neglect no opportunity of increasing. The careful buyer first informs himself as to the resources of the market, second, he pays nothing more for the reputation of a fertilizer or for the claims made as to its superiority than he can satisfy himself that they are worth, but he buys with strict reference to the quantity and quality of the ingredients, and bases his opinion of the quantity and quality on the evidence of chemical analysis. Third, he prefers, if possible, and it usually is possible, to buy sufficiently pulverized raw materials and mix them himself rather than pay a profit on grinding and manipulating. Fourth, he plans and buys ahead when the market is dull. Fifth, he clubs with his neighbors to purchase in large quantity and thus secures wholesale rates. Lastly, he pays cash down and saves his interest.

We have already seen (p. 30) that the nitrogen in genuine ground bone, has cost during the season of 1879, from 11 to 15 cents per pound, according to the degree of fineness of the bone, instead of from 15 to 18 cents, the rates of the Station valuation. We have seen also (p. 34) that in damaged cotton and linseed meal, nitrogen has been bought for 13 cents per pound. Probably, however, there is no considerable or steady supply of nitrogen in this form. Undamaged cotton seed meal commands in New York, according to December quotations (1879) $24.50 per ton. If we add to this cost $3.00 per ton for transportation to Connecticut markets we have the cost of nitrogen 15.8 cents, the cost in New York being 14 cents. It is a well ascertained fact of experience that the nitrogen of cotton seed is not inferior to that of meat, blood, or ammonia-salts in average fertilizing effect. The supply of cotton seed meal is large, and although its most legitimate agricultural use is as a cattle food, it is seen to stand close to pure ground bone as a cheap source of organic nitrogen for manurial purposes.

In standard Peruvian guano (p. 25) organic nitrogen has also been furnished at 16 cents per pound.

It thus appears that while the Station has rated organic nitrogen in its most active forms at 20 cents, it has been retailed in cotton seed meal and in Peruvian guano for 16 cents, in fine bone for 15 cents, and in damaged cotton seed meal for 13 cents per pound, while its wholesale price in fish and blood has been as low as 10½ cents.

Nitrogen in the forms of Ammonia-salts and Nitrates.—Sulphate of ammonia has not figured in our retail market. It has been quoted at $80 per ton, which would make nitrogen cost 20½ cents per pound. The sample of standard Peruvian guano **292** which contained a good share of its nitrogen in the form of ammonia supplied it for 18 cents per pound.

The Station has no trustworthy data with reference to the present cost of *nitrates*.

Soluble Phosphoric acid.—The imported superphosphates **291** and **298** p. 25, whose value lies exclusively in their phosphoric acid which is nearly all soluble in water, furnish this ingredient for 11 cents per pound. In standard guano **292**, soluble phosphoric acid costs 10 cents per pound.

Reverted phosphoric acid.—In standard Peruvian guano this ingredient costs 7½ cents.

Insoluble phosphoric acid.—The various grades as we have seen (p. 30) have been furnished in ground bone at reduced rates.

In the following statement we give: 1. The trade values employed by the Station during 1879, and which, as we have seen, correspond with the average retail cost of superphosphates, guanos, other than Peruvian, and "special fertilizers." 2. The cost of the fertilizing elements during 1879, as supplied in bone, Peruvian guano, cotton seed, English superphosphate and potash salts.

	1 Cost in Superphosphate, Specials, &c. Cts. per lb	2 Cost in Per. Guano, Cotton Seed, &c. Cts. per lb.
Nitrogen in nitrates,	26	?
" in ammonia salts,	22½	18
" in Peruvian Guano (organic) fine steamed bone, dried and fine ground blood, meat and fish,	20	16
" in fine ground bone, horn and wool dust,	18	15
" in fine medium bone,	17¼	14
" in medium bone,	16½	13
" in coarse medium bone,	15¾	12
" in coarse bone, horn shavings and fish scrap,	15	11
Phosphoric acid, soluble in water,	12½	11
" " "reverted" and in Peruvian Guano,	9	7½
" " insoluble, in fine bone and fish guano,	7	6
" " " in fine medium bone,	6½	5½
" " " in medium bone,	6	5
" " " in coarse medium bone,	5½	4½
" " " in coarse bone, bone ash and bone black,	5	4
" " " in fine ground rock phosphate,	3½	?
Potash in high grade sulphate,	7½	
" in low grade sulphate and kainite,	6	5
" in muriate or potassium chloride,	4½	3¾

We see that in the second class of fertilizers the fertilizing elements have cost 20 per cent. less than in the first class. Whether the elements in the first class are, on the whole, 20 per cent. better in practical effect, as a result of better pulverization uniformity of composition, safety or convenience in application, facility or favorable terms of purchase, proportions in which the element occur, or other real or supposed advantage is a question which each purchaser must answer for himself.

The Station will retain for the coming year the valuations used in 1879. The present upward tendency of prices renders it inexpedient to make any change, and they answer perfectly for the purpose of comparing one fertilizer with another.

INQUIRIES AND ANSWERS CONCERNING THE USE AND MANAGEMENT OF MANURES.

Application of Stable Manure.

Director of the Experiment Station: Will you please inform me which is the better practice, to deposit manure in small heaps plowing it under directly after spreading, or to spread it broadcast from the cart, plowing it under when convenient? Some claim that there is more loss in the latter practice from washing and evaporation. Is it best to put it on the field in winter?

B. L. Tuttle, Milldale.

Answer.

Manure from yard or stable rarely contains such an amount of volatile fertilizing matters (carbonate of ammonia) as should deter from spreading it broad-cast on the surface when most convenient. In Report of Connecticut Board of Agriculture for 1873, p. 350, you will see from the analysis of a sample of "fresh horse manure," that 10,000 pounds of it contained but 22 pounds of nitrogen in the form of ammonia salts that could be evaporated by prolonged boiling with water, while "fresh cow manure" and "old yard manure" contained but 6 pounds and 1 pound, in 10,000 pounds respectively. Unless manure is very rich, as from grain-fed animals, and is in an active stage of fermentation, hot and smoking, and exhales a distinct smell of ammonia (hartshorn) there can be no loss on exposure, and in any case the loss will be less by spreading out thinly, than by dropping in small heaps, because spreading implies cooling and the stop of fermentation. The soil, if not mere sand, is an energetic absorber of ammonia and will not allow much to escape.

But manure, when properly handled, need not suffer any waste from evaporation. A moderate and regulated heating of fresh manure, results in the formation of *humic acid* which secures the ammonia from loss by evaporation. This moderate heating it should have before hauling out, or else it should be hauled out in cold weather before it heats at all.

The advantages of spreading manure from the wagon as it is drawn out are, a saving of labor and an even distribution of the soluble salts (ammonia, potash, phosphates, etc.), in the soil by rain. If the manure is heaped on the field and gets a heavy rain before spreading, the ground under the heaps receives an undue share of the best part of the manure.

Independently, however, of loss by evaporation, there may be circumstances when it is best to get the manure into the ground, before it has had a chance to become dry, for it distributes much better when moist and swollen with water than when "chippy" or "snuffy" in texture, and is ready at once to act as manure, whereas dry manure must recover moisture before it can be of any use.

As to spreading manure on the ground in winter, the practice works well where the ground is level or not subject to surface wash, and where the soil is deep and retentive (clay or good loam) or covered with grass or winter grain. On bare, light or leachy lands there is likely to be too much loss by percolation before the crops are ready to take up the fertilizing matters.

The surface application acts very beneficially as a mulch on lands that puddle in rain and cake in sun, and on them saves or reinforces tillage.

The application of manure is a matter in which circumstances alter cases, and in deciding on the course to pursue in every instance the circumstances should be carefully considered. The benefits of a mulch or the convenience of the farmer may often compensate for some loss of manure.

The question whether manure is better applied *fresh* or after *thorough fermentation*, is not touched in these remarks.

Bones, Raw and Boiled.

Director Experiment Station: I find that some of the bone-dust that is sold in the market has the oil extracted before grinding, and some of it is ground with the oil in it. One is quite dry and the other is wet and heavy. Is oil a fertilizer; if so, is it worth one and a half cents per pound or thirty dollars per ton or any part of that money, either in its raw state or combined with oil of vitriol as in a phosphate?

John S. Welles, Hebron, Ct.

Answer.

The pure oil, or fat of bones, is good for nothing as a fertilizer. In extracting the oil, however, by boiling, the bones lose some nitrogen in the form of gelatine (glue). The loss thus occasioned is usually not large, and is compensated by the greater ease of grinding and more ready decomposability of the boiled bones, if applied as bone-dust, or by the less grinding, less acid, and less time required to work into a superphosphate. The boiled bones come out of the boilers saturated with water. To dry them by artificial heat is costly, and to make them suitable to handle and prevent putrefaction they are often mixed with salt cake, or niter-cake (a refuse sulphate of soda), and sometimes this cheap chemical is used in large proportion, 30 or more per cent. It thus happens that boiled bones are quite variable in value and composition, especially since more or less meat and "tankings" are mixed with the bones.

Composting Manure with Fish.

Director of Experiment Station: I have a large pile of barn yard manure rather coarse. I want to make a compost heap, and have been told if I would buy white-fish pomace or fish guano and mix them that it would be the best thing to do. Others say that the one counteracts the other. Please advise me what to do.

A. L. Collins.

West Meriden, May 28th.

Answer.

Fish pomace would help reduce your coarse manure and I cannot understand that one would counteract the other. The manure itself, if kept moderately moist, would soon become compost in this weather. Addition of fish pomace would hasten the operation. A little fresh slaked lime or wood ashes would also aid the process. A coating of earth, loamy or mucky, would prevent loss and regulate the heating. The fish or lime or ashes (or all three) should be well mixed with the manure.

Hen Manure—Loss by Heating—Mixing with Plaster.

Director of the Experiment Station: I send you by express a sample of hen manure, taken from my roost, for analysis.* I never have weighed any but judge that it weighs not far from 50 pounds per bushel as I ordinarily find it. I find that after standing in barrels for several weeks it sometimes appears mouldy. I have thought it to be caused by heating, if so is it an injury to the manure. Have usually sprinkled the tops of the barrels with plaster. Would not that prevent the loss of ammonia in case any was set free by decomposition?

L. H. Gager.

Quarryville, April 14, 1879.

Answer.

The mouldiness is a sign of moderate heating and probably is accompanied by some loss of value, but unless there is a *strong* odor of ammonia the loss will not be considerable. The sample has a slight smell of ammonia.

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* The analysis is given on p. 84.

Dry plaster will not stop ammonia or prevent its loss. Plaster and *wetness* (not mere dampness) will check the escape of ammonia. Water alone, enough to fill the pores of the mass, especially if the manure be made compact, will prevent much loss in cool weather. Plaster, *in solution*, i. e., wet, arrests decomposition, as well as retains any ammonia that has been generated.

Mixing Nitrogenous Fertilizers with Ashes and Potash Salts.

Director of the Experiment Station: I am told that ashes, owing to the potash in them, when mixed with a nitrogenous fertilizer release the nitrogen. Is this true?

Is there any objection to mixing either muriate or sulphate of potash with a nitrogenous fertilizer, and if any, what? An early answer will greatly oblige,

L. S. Ellsworth, Simsbury, Conn.

Answer.

When ashes which contain *carbonate of potash* are mixed with a nitrogenous fertilizer, the effects differ according to circumstances. If the fertilizer contains its nitrogen as nitrates or in the form of organic compounds such as fish scraps, flesh, blood, or the similar albuminoids of vegetables, as in castor pomace and cotton seed, no nitrogen will be released, but when nitrogen exists in the form of *ammonia salts*, then carbonate of ammonia may escape, and will escape if the mass is moist and exposed to air and sun, so that evaporation of the water takes place. Fish scrap often contains a little ammonia salts, because it cannot always be dried before decomposition commences.

In most cases, mixture of ashes with stable manure, hen dung, guano and other animal fertilizers will occasion no serious loss if the mixture is shortly incorporated with the soil, or if the mixture be covered with a layer of loamy or peaty earth, because the quantity of nitrogen existing as ready formed ammonia in these fertilizers is usually very small; and the liberated carbonate of ammonia is perfectly retained by the moist earth. If ashes are mixed with *moist* hen dung or Peruvian guano, the smell of ammonia is at once perceived, but addition of loam speedily arrests the loss. It requires exceedingly little ammonia to affect the sense of smell and the amount of loss is therefore easily over-estimated when judged of by the odor.

There is no objection to mixing sulphate or muriate of potash with any nitrogenous fertilizer.

Composition of Castor Pomace and Cotton Seed.

Director Connecticut Experiment Station: The Farmers and Tobacco Growers in this vicinity are interested to know the analysis of castor bean, cotton seed and castor pomace. Can you give me the proportion of castor bean and cotton seed in castor pomace, with their relative values as a fertilizer.

Yours, JOHN N. KING.

South Windsor, Ct., March 25.

Answer.

The composition of the castor bean and of cotton seed I am unable to give. In 1857–8 I analyzed samples of castor pomace and of decorticated cotton cake, and found their composition to be as follows:

	1858. Castor Pomace.	1857. Cotton seed Cake.
Water,	9.24	6.82
Oil,	18.02	16.47
Other vegetable matters,	66.60	68.91
Ash,	6.14	7.80
	100.00	100.00
Nitrogen in vegetable matters,	4.32	7.05
Phosphoric acid in ash,	2.09	2.86
Worth, calculated at present trade values, (N. 20c., P. A., 9c.)	$21.04	$32.45

Both these articles are simply what remains after the seeds have been crushed and subjected to extreme pressure to extract the oil. Their composition will vary according to the extent to which the oil is withdrawn, and according to the state of dryness of the cake. In case of cotton seed it makes a great difference whether the hulls are removed before expressing the oil. I believe decortication is now generally practiced, at least I have not seen of late any cake made from unhulled seed. In seven analyses of castor pomace before me, nitrogen ranges from 4 to 5.3, averaging 4.6 per cent., and phosphoric acid from 1.5 to 2.5, averaging 2 per cent. A sample analyzed at the Station last year contained 1.5 phosphoric acid, and 4.6 nitrogen. Its cost was $22, and its estimated value was $21.06 per ton.

Cotton seed meal has not fallen in my way of late years.* Dr. Wolff gives the average composition of this article as found in the German markets as follows:

	Unhulled.	Hulled.
Water,	11.5	12.2
Nitrogen,	3 9	6.2
Phosphoric acid,	2.8	——
Worth, at present trade values,	$20.64	$28 (?)

The absence of phosphoric acid in Wolff's statement respecting hulled cotton cake, makes the valuation uncertain by one or two dollars. Cotton seed cake and castor pomace also contain 1 to 2 per cent. of potash, not given in the above analyses, which would add a dollar or more to the valuation. I am not aware that castor pomace ever contains any cotton seed. If the two are mixed, the practiced eye would, I think, detect the fact, and chemical analysis will show the value of the mixture. You will see from the analysis above given that genuine castor pomace stands intermediate in value between hulled and unhulled cotton seed cake.

Gas Lime.

Director Experiment Station: I see nothing in your reports about lime that has been used at gas works. It kills all seed that comes in contact with it. My land is wet and needs nitrogen, I judge, as I have success with fish scraps. Is the gas lime worth anything for such land?

N. P. PERKINS.

Willimantic, April 11, 1879.

Answer.

Lime is used in the gas manufacture to purify the gas from sulphur, which it retains in the form of *sulphide of calcium*. This compound dissolves freely in water and acts like strong lye, upon vegetation. Hence the destructive effects of gas lime fresh from the purifiers. On exposure to the air the sulphide of calcium is gradually converted into sulphate of lime or "plaster." When this change is accomplished the gas lime loses its odor and also becomes tasteless. Then it may be applied as plaster or lime is applied, and is, in fact, a mixture of sulphate and carbonate of lime. The fresh gas lime would be an excellent material in the compost for dissolving or disintegrating bones, leather shavings, hair or similar matters which requires energetic agents to reduce them to a pulverulent state, admitting of easy and profitable use as fertilizers.

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* After the above was written, the two samples 289 and 297 were analyzed. See p. 84.

To prepare fresh gas lime for use as a fertilizer, it may be spread out on a layer of moist swamp muck, leaf mold, or other coarse vegetable matter, and exposed to rain and air until the odor and taste are gone. The underlying bed of muck, etc., would be advanced on its way to manure and the washings of the gas-lime saved.

By the use of lime, it often happens that nitrogen, which exists in the soil in large amount, but in a dormant or inert state, is made available to vegetation. This is especially the case in mucky and clayey lands, or where stable manure and other animal fertilizers have been copiously applied. The favorable result of a trial with a purely nitrogenous fertilizer, does not prove that the land needs nitrogen but only shows that it is relatively deficient in available nitrogen. Lime is one of the most effective agents in converting the fixed capital of the soil into floating capital to serve for the speedy realization of crops and while it may be applied on any crop, usually works best—so British practice goes to show—put on grass or winter grains as a top dressing, early in spring or late in fall, so that it may get a good distribution by rain.

Test for Adulteration of Leached Ashes.

Director of the Experiment Station: Is there a simple chemical test for the detection of coal-ashes in wood-ashes. With the present low price of coal it is quite risky to buy leached ashes.

HENRY BALDWIN.

South Canterbury, May 27th.

Answer.

Wood-ashes can be tested for coal ashes most simply by putting a few handfuls in a pan, wetting the whole thoroughly and stirring under a gentle stream of water. The fine ashes will float away in the overflowing water, leaving, in case of pure wood ashes or leached wood ashes, merely some charcoal and sand which are always present in wood ashes. If coal ashes are intermixed bits of half-burned coal and lumps of slag or clinker will also remain, which can easily be identified and, from their quantity, some idea of the extent of the adulteration can be formed. Suspected samples may be sent to the Station for further examination.

SILICA IN PLANTS.

Ever since Sir Humphrey Davy suggested that the silica which occurs in considerable proportion in the stems and leaves of grasses *might be* essential to the strength of these plants the notion has been gaining ground in the popular mind that this silica is indispensable to their strength; that its absence causes the "laying" or "lodging" of the cereals, and that the farmer must regard silica as an essential element of fertilizers and must provide for its supply to crops. The Pŏpplein fertilizer which, as usual, bears high practical and pseudo-scientific endorsement, has "soluble silica" as the strong point of its "philosophy," and the questions are continually recurring—*is* silica one of the elements to be regarded in supplying the wants of crops, is it concerned in the stiffening of the stalks of grain, is it necessary to the growth of any plant, has it any use in the vegetable economy?

We have not space here to discuss these questions in detail, and in the present state of agricultural science there is little use in going beyond the solid experimental evidence which investigations have brought to bear upon them.

1. It has been conclusively shown that the strength of straw does not depend upon the silica in it, but upon the vegetable substance itself. Rapid growth produces, in presence of abundant silica a comparatively loose and weak cell tissue. Slow growth, on the other hand, yields in practically total absence of silica firm and close textured stems. Again, no fertilizing experiments in which soluble silica has been supplied have shown any benefit from the silica. Finally, there is no element so abundant in all soils, and none whose access to crops is so impossible to avoid.

2. Numerous most careful trials on the growth of plants under circumstances where silica has not, and could not, be supplied to them except in most minute quantities, have demonstrated beyond all question that silica is not necessary to the nutrition or complete development of agricultural plants.

It has lately been shown by Hohnel that the seeds of the stonecrop (Lithospermum arvense) which contain four times as much silica as wheat straw, being literally incased in a silicious coating, when grown under natural conditions, may be produced in absence of silica without any appearance of suffering from the lack of this substance.

It appears probable from recent investigations, that silica is of use in the plant, that its presence in the soil stands connected with the uniform ripening off of cereals and that its presence in their stems enables them to resist the attacks of fungi. But these points are not proved, and it is not unlikely that silica stands in relation to these consequences as a coincidence rather than as a cause.

The Strawberry Crop—Its Chemical Composition and Requirements.

Director Experiment Station: I am considerably interested in the cultivation of small fruits, particularly strawberries, and am anxious to know the best fertilizers to use. I would like to know if any analysis of the fruit has been made, and, if so, the results. I do not recollect of seeing any. Have seen it stated that about one-half of the ash of the fruit is potash, if so some manure rich in potash would seem to be the most desirable to use. Have used stable manure, but the result is not near as satisfactory as it used to be some years ago. Have a good growth of vines and fruit stalks but the fruit does not grow to ripen even when the blight does not injure them. I wish an analysis could be made so we could work intelligently about the treatment to be pursued. I am sure a large number of fruit growers will join in my request.

Yours, P. A. Sears, Elmwood, Ct.

*Answer.**

I find two analyses of the ash of the fruit of the strawberry, which are as follows:

Composition of Ash of Strawberry Fruit.

	Richardson. 1848.	Pierre. 1863.
Potash,	21.07	40.3
Soda,	28.48	1.8
Lime,	14.20	16.7
Magnesia,	——	1.5
Oxide of iron,	5.89	7.8
Phosphoric acid,	18 82	11.1
Silica,	12.05	3.1
Sulphuric acid,	8.15	17.7
Chlorine,	1.69	
Carbonic acid,		
Per cent. of ash in fruit,	8.40	4.38

When the first analysis was made, by Richardson, the processes used were far less exact than those we now possess and the analysis is doubtless incorrect in some particulars. Doubtless nearly all of the so-called soda was really potash and a share of the so-called lime was magnesia. Probably also much of the silica was adhering sand.

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* Rewritten and condensed from two articles printed in the Connecticut Farmer.

The analysis by Pierre is not quite complete but it serves to exhibit the composition of the ash with sufficient accuracy for our present purpose.

Pierre gives a statement of the composition, exclusive of water, of the total yield *per hectare* of fruit, taken up to June 30, and of leaves, stems, and runners, taken up to the middle of August. These results calculated in pounds per acre are the following: The plants contained 62.3 per cent. of water and the vines 30 per cent.

Composition of the water-free Strawberry Crop (except roots), at the middle of August, in lbs. per acre, according to Pierre.

	Plants.	Fruit.	Total.	*Composition of 3500 lbs. of moderately rotted stable manure.—Wolff.*
Organic matter exclusive of nitrogen,	4268.4	1058.5	5321.9	
Nitrogen,	88.5	16.0	104.5	17.5
Silica, Iron and Manganese Oxides,	43.3	1.5 3.8	48.6	58.8
Phosphoric acid,	35.3	5.4	40.7	9.1
Lime,	102.7	7.9	110.6	24.5
Magnesia,	16.1	.7	16.8	6.3
Potash,	89.1	19.7	108.8	22.1
Soda,	6.4	.9	7.3	6.7
Other matters,	120.9	8.8	129.7	——
Dry substance,	4770.7	1118.2	5888.9	

This investigation by Isidore Pierre was made in 1862 at Caen, in France, with the variety known as *Comte de Paris*, and is described in his *Agronomie*, T. 2, p. 156.

I calculate from Richardson's analysis (assuming what he called soda to be really potash), that 1,000 lbs. of dry (water-free) fruit, or 10,000 lbs. of fresh fruit, remove 18 lbs. of potash from the soil.

Pierre makes the export of potash in 1,118 lbs. of water-free fruit 19.7 lbs. The important substances removed by 1,100 lbs. of the dry matter of strawberries are quite similar in amount to those contained in 1,000 lbs. of good timothy hay, which are: nitrogen, 15.5 lbs.; potash, 20; soda, 1.5; lime, 4.5; magnesia, 1.9; phosphoric acid, 7.2; sulphuric acid, 1.8.

If we regard the entire plant (roots excepted), the case is quite different. The foliage and stems contain, on the average, some five times as much of the various elements as the fruit alone.

Pierre reckons that the entire crop, in the three years which he says it usually occupies the ground, requires three times the quantities of the various elements given above in the "total," thus implying that the annual demand of the crop is fairly expressed by that total. If such be the case, the exhaustion consequent on taking off the entire crop is quite exactly equal to that caused by the removal of 2¾ tons of red clover hay (reckoned by Wolff's tables), except that the amount of phosphoric acid is somewhat larger in the strawberry than in the clover crop.

The quantity of fresh fruit in the above calculation (which Pierre considered to be rather below the actual produce upon his land), amounts, in round numbers, to 11,000 lbs. per acre.

These data make it nearly certain that your diminished crops are not the result of exhaustion of potash, nor of any or all the soil-elements which go to make the strawberry plant.

Certainly there can be no difficulty in restoring to the soil the substances removed by half a ton of timothy hay. Such a restoration is all that is needful if only the fruit be exported. There is no difficulty in practice in returning to the soil nearly all but the fruit, for the old vines, runners and roots are worth nothing except to plow under or put into compost, and the young plants used for propagation, carry to the new planting all they take from the old. So that except in first establishing the planting or in raising plants for market, the farm suffers no export but that of fruit, and 3,000–3,500 pounds of good stable manure is sufficient to make good what the fruit removes, as seen from the comparison in the foregoing table of analyses.

Nevertheless, the strawberry ranks as an "exhausting crop," because it ordinarily requires high manuring to make it successful. This high manuring is usually necessary, partly because the plants, in order to make their culture remunerative, must grow rapidly at the fruiting season and must therefore be highly fed with those substances which agricultural chemistry has of late years made so prominent in the minds of intelligent farmers, viz: nitrogen, potash, phosphoric acid, lime, etc. But all the manure commonly employed, can hardly be needed for that purpose. Much of it, I can scarcely doubt, finds its use in ensuring or regulating the water supply, and equalizing the termperature. It is certain that a skillful irrigation would take the place of a good share of the yard manure now generally regarded as indispensable. This fact, while it does not show that irrigation is, for us a cheaper mode of raising strawberries, does make plain that the production of fruit is not simply and solely a matter of the supply of nitrogen and of potash and like ash elements, but that other conditions connected with the so-called physical or mechanical qualities of the soil, are important for the welfare of vegetation and should be understood and kept in view by the cultivator.

In your case stable manure does not now prove so satisfactory as it formerly did. You "have a good growth of vines and fruit stalks, but the fruit does not grow to ripen even where the blight does not injure them."

In my opinion the difficulty does not lie in any deficiency of plant-food. I should say that whenever a highly developed plant is produced up to the point of fruiting, that fact demonstrates that the soil is wanting in nothing required for fruiting. The fruit contains nothing that is not needful for leaves, stems and root, and it can scarcely happen in agricultural practice, that a plant can grow up to the point of fruiting and then fail to perfect fruit on account of a cessation in the supplies of plant-food, except such as would happen from drought. When its conditions for growth are already highly favorable, any attempt to push to greater production by excess of plant-food, especially by excess of nitrogenous matters, often or generally results in development of foliage and stem at the expense of fruit, whereas whatever limit the supply of food, as drought or poor soil, tend to early, and relatively to the foliage, abundant fruiting. I am therefore inclined to believe that the soil and manure in case of your strawberries have not failed to nourish the plant sufficiently, but more likely have fed it too well.

A strawberry field highly manured, manured in fact to the verge of excess, may give a good crop when the weather is by its coolness and dryness just favorable to vegetation, but may fail of its crop when the heat and moisture at the flowering and fruiting time are excessive. What would be most favorable for foliage, stalk and runner, would be excessive for fruit. It is the equable climate of England which enables its farmers to get almost regularly heavy grain and grass crops, although they cannot raise Indian corn or grapes at all. So also the irrigated fields of Colorado and California produce large crops, sometimes

80 bushels of wheat per acre,—for the reason that the water supply is under the same control as the supply of soil-food.

VALUE OF SAWDUST AS A FERTILIZER AND ABSORBENT.

Answer to a Question from the Connecticut Farmer.

Sawdust has very little, one may almost say no value as a direct source of plant food. The sawdust from pine, spruce and other resinous woods, may be a disadvantage to crops when applied fresh, in large quantities, the turpentine or resin acting as a poison.

As an absorbent, sawdust is excellent and far better than sand, because: 1st, it is, bulk for bulk, more absorbent; 2d, it is much lighter and therefore for equal cost of handling far more absorbent than sand; 3d, when saturated with dung liquor, it very readily decays in the soil or compost, and then acts in the same way as stable manure chiefly acts, viz: by improving the texture and water-storing capacity of soils, and—by the humic acid of its decay—acting as a solvent in the soil, renders the inert plant food more rapidly available to crops.

Sand, so strenuously advocated by some as an absorbent, appears to me to cost in its handling more than it can commonly be worth. Vegetable matter of some kind is the best absorbent, and can usually be got for less than the cost of carting sand in and out of the stables. Unlike sand, it has, after mixing with manure, a value of its own as an application to land, which can rarely be said of sand, in Connecticut, where putting it on the fields is, in the majority of cases, like carrying coal to Mauch Chunk. Even in clay lands, vegetable matter is a better ingredient of stable manure than sand. If otherwise, the farmer should mix sand with three or four per cent. of chemicals, representing the direct fertilizing value of stable manure, and discard dung and urine altogether.

FODDER AND FEEDING STUFFS.

Of this class of agricultural products, thirty-three (33) samples have been analyzed during the year 1879, viz:

19 of meadow hay.
1 of Hungarian millet.
9 of maize kernel.

1 of maize stover.
2 of hominy chops.
1 of linseed meal.

Before entering into details of these analyses, I copy here from former Reports some paragraphs that may serve to explain what is to follow.

Thanks to the laborious investigations carried on of late years in the Experiment Stations and University Laboratories of Europe and especially of Germany, the simple analysis of an article of cattle food may be usefully employed in fixing its place and nutritive value in the feeding-ration, and also in deciding how much the farmer can afford to pay for it, or at what price, and to what extent he can substitute it for other materials customarily used.

In order to make our analyses of cattle feed directly useful, it is needful to adduce some of the results of the prolonged study of this subject made in other countries.

The following Table of the Composition and Contents of Digestible Nutritive Ingredients and Money Value of some of the most important Feeding Stuffs (page 75). is taken from the German of Dr. Emil Wolff, of the Agricultural Academy at Hohenheim, and represents the most recent and most trustworthy knowledge on these subjects.*

The *composition* of feeding stuffs, as here stated, is the average result of the numerous analyses that have been made within twenty-five years, mostly in the German Experiment Stations.

The *quantities of digestible nutrients* are partly derived from actual feeding experiments, and are partly the result of calculation and comparison.

The percentage of the *three classes* of digestible matters, viz: *Albuminoids*, † *Carbhydrates*‡ and *Fat*, form the basis of calculating the money value of feeding stuffs. The values attached to them by Dr. Wolff are the following, the German mark being considered as equal to twenty-four cents, and the kilogram equal to 2.2 pounds avoirdupois.

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* From "*Mentzel u. Lengerke's Kalender*," for 1879.

† The Albuminoids here include a proportion of *amides* whose quantity in feeding stuffs has very recently become a subject of investigation, and whose nutritive value is not yet fully understood.

‡ The "nitrogen free extract" (N. fr. Extract) in grains consist almost exclusively of carbhydrates, viz: starch, sugar, gum, and allied bodies; in grass and hay it includes, in addition, substances of whose properties we are ignorant but which, so far as they are *digestible*, rank with the carbhydrates.

1 pound of digestible albuminoids is worth 4⅓ cent.
1 " " fat " 4⅓ "
1 " " carbhydrates " 9/10 "

These figures express the present average *money values* of the respective food elements in the German markets. Whether or not these values are absolutely those of our markets, they represent presumably the *relative* values of these elements approximately, and we may provisionally employ them for the purpose of comparing together our feeding stuffs in respect to money value.

These money or market values are to a degree independent of the feeding values. That is, if of two kinds of food, for example, Hungarian hay and malt sprouts, the one sums up a value of 66 cents, and the other a value of $1.21 per hundred, it does not follow that the latter is worth for all purposes of feeding twice as much as the former, but it is meant that when both are properly used, one is worth twice as much money as the other. In fertilizers we estimate the nitrogen of ammonia salts at 22½ cents per pound, and soluble phosphoric acid at 12½ cents, but this means simply that these are equitable market prices for these articles, not that nitrogen is worth twice as much as soluble phosphoric acid for making crops. In the future more exact valuations may be obtained from an extensive review of the resources of our markets, in connection with the results of analyses of the feed and fodder consumed on our farms.

The column headed "nutritive ratio" in the table on page 75 gives the proportion of digestible albuminoids to digestible carbhydrates inclusive of fat.* The albuminoids, which are represented in animal food by the casein or curd of milk, the white of egg and lean meat, and in vegetable food by the gluten of wheat (wheat gum), and other substances quite similar to milk-casein and egg-albumin, have a different physiological significance from the carbhydrates, which are fiber or cellulose, starch, the sugars, the gums, and similarly constituted matters.

The albuminoids may easily be made over by the animal into its own substance, i. e., into muscles, tendons, and the various working tissues and membranes which are necessary parts of the animal machine, because they are the same kind of materials, are, chemically speaking, of the same composition.

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* Fat and carbhydrates have, it is believed, nearly the same nutritive function, and it is assumed that 1 part of fat equals 2.4 of carbhydrates.

The carbhydrates, on the other hand, probably cannot serve at all for building up the muscles and other parts of the growing animal, and cannot restore the waste and wear of those parts of mature animals, because they are of a very different nature. They contain no nitrogen, an element which enters into all the animal tissues (albuminoids) to the extent of some fifteen per cent. of their dry matter.

The carbhydrates cannot restore the worn out muscles or membranes of the animal any more than coal can be made to renew the used up packing, bolts, valves, flues and gearing, of a steam-engine. The albuminoids are to the ox or the man what brass and iron are to the machine, the materials of construction and repair.

The carbhydrates are, furthermore, to the animal very much what coal and fuel are to the steam-engine. Their consumption generates the power which runs the mechanism. Their burning (oxidation) in the blood of animals produces the results of life just as the combustion of coal in the fire-place of the steam-engine produces the motion and power of that machine.

There is, however, this difference between the engine and the animal. The former may be stopped for repairs, the latter may run at a lower rate, but if it be stopped it cannot resume work. Hence the repairs of the animal must go on simultaneously with its wastes. Therefore, the material of which it is built must admit of constant replacement, and the dust and shreds of its wear and tear must admit of escape without impeding action. The animal body is as if an engine were fed with coal and water not only, but with iron, brass and all the materials for its repair, and also is as if the engine consumed its own worn out parts, voiding them as ashes or as gas and smoke. The albuminoids, or blood- and tissue-formers, are thus consumed in the animal, as well as the carbhydrates, or fuel proper. The fact that the albuminoids admit of consumption implies that when the carbhydrates or proper fuel are insufficient, they, the albuminoids, may themselves serve as fuel. Such is the case, in fact. But, nevertheless, the two classes of substances have distinct offices in animal nutrition, and experience has demonstrated what science predicted, viz: that for each special case of animal nutrition a

Average Composition, Digestibility and Money Value of Feeding Stuffs as given by Dr. Wolff for Germany for 1879, *except those in italics.*

	Water.	Ash.	Nitrogenous Matters, Albuminoid and Amides	Fiber.	N. fr. Extract.	Fat.	Digestible nutrients.			*Nutritive Ratio.	Value.	
							Albuminoids.	Carbhydrates incl. fiber.	Fat.		Dollars per 100 pounds.	Comparison with meadow hay = 1.
Meadow hay, poor......	14.3	5.0	7.5	33.5	38.2	1.5	3.4	34.9	0.5	10.6	0.48	0.74
" " fair.......	14.3	5.4	9.2	29.2	39.7	2.0	4.6	36.4	0.6	8.3	0.55	0.86
" " average...	14.3	6.2	9.7	26.3	41.4	2.5	5.4	41.0	1.0	8.0	0.64	1.00
" " very good	15.0	7.0	11.7	21.9	41.6	2.8	7.4	41.7	1.8	6.1	0.74	1.17
" " extra.....	16.0	7.7	13.5	19.3	40.4	3.0	9.2	42.8	1.5	5.1	0.84	1.32
Clover hay, average....	16.0	5.3	12.3	26.0	38.2	2.2	7.0	38.1	1.2	5.9	0.69	1.08
" best	16.5	7.0	15.3	22.2	35.8	3.2	10.7	37.6	2.1	4.0	0.88	1.39
Timothy hay..........	14.3	4.5	9.7	22.7	45.8	3.0	5.8	43.4	1.4	8.1	0,69	1.09
Hungarian hay.........	13.4	5.7	10.8	29.4	38.5	2.2	6.1	41.0	0.9	7.1	0.66	1.04
Rye straw............	14.3	4.1	3.0	44.0	33.3	1.3	0.8	36.5	0.4	46.9	0.35	0.55
Oat "	14.3	4.0	4.0	39.5	36.2	2.0	1.4	40.1	0.7	29.9	0.44	0.69
Rich pasture grass	78.5	2.2	4.5	4.0	10.1	1.0	3.4	10.9	0.6	3.6	0.27	0.42
Average meadow grass, fresh...............	70.0	2.1	3.4	10.1	13.4	1.0	1.9	14.2	0.5	8.1	0.22	.36
Green maize, German...	85.0	1.0	1.2	4.7	7.6	0.5	0.7	7.4	0.2	11.3	.10	.16
" *Mr. Webb*, 1874	86.0	0.8	0.8	4.8	7.3	0.3	0.6	8.3	0.2	14.4	.11	.17
Cured Maize Fodder, Mr. Webb	27.3	4.2	4.4	25.0	37.9	1.3	3.2	43.4	1.0	14.4	.57	.91
Potatoes	75.0	0.9	2.1	1.1	20.7	0.2	2.1	21.8	0.2	10.6	.29	.46
Carrots...............	85.0	0.9	1.4	1.7	10.8	0.2	1.4	12.5	0.2	9.3	.18	.28
Mangolds..............	88.0	0.8	1.1	0.9	9.1	0.1	1.1	10.0	0.1	9.3	.14	.22
Rutabagas.	87.0	1.0	1.3	1.1	9.5	0.1	1.3	10.6	0.1	8.3	.15	.24
Turnips	92.0	0.7	1.1	0.8	5.3	0.1	1.1	6.1	0.1	5.8	.11	.16
Sugar beets...........	81.5	0.7	1.0	1.3	15.4	0.1	1.0	16.7	0.1	17.0	.19	.30
Maize, German	14.4	1.5	10.0	5.5	62.1	6.5	8.4	60.6	4.8	8.6	1.10	1.78
" *American*...... .	14.4	1.5	10.7	2.0	66.5	4.9	9.0	63.8	3.7	8.0	1.12	1.75
Oats..................	14.3	2.7	12.0	9.3	55.7	6.0	9.0	43.3	4.7	6.1	.97	1.53
Rye	14.3	1.8	11.0	3.5	67.4	2.0	9.9	65.4	1.6	7.0	1.09	1.68
Barley	14.3	2.2	10.0	7.1	63.9	2.5	8.0	58.9	1.7	7.9	0.95	1.47
Peas..................	14.3	2.4	22.4	6.4	52.5	2.0	20.2	54.4	1.7	2,9	1.44	2.25
Field Beans	14.5	3.1	25.5	9.4	45.9	1.6	23.0	50.2	1.4	2.3	1.51	2.36
Squashes..............	89.1	1.0	0.6	2.7	6.5	0.1	0.4	7.1	0.1	18.4	.08	.13
Malt sprouts..........	10.1	7.2	24.3	14.3	42.1	2.1	19.4	45.0	1.7	2.5	1.31	2.06
Wheat bran, coarse.....	12.9	6.6	15.0	10.1	52.2	3.2	12.6	42.6	2.6	3.9	1.04	1.63
" fine.......	13.1	5.4	14.0	8.7	55.0	3.8	11.8	44.3	3.0	4.4	1.08	1.62
Middlings	11.5	3.0	13.9	4.8	63.5	3.3	10.8	54.0	2.9	5.7	1.07	1.68
Rye Bran..............	12.5	5.2	14.5	5.7	58.6	4.5	12.2	46.2	3.6	4.5	1.10	1.72
Palm-nut cake	10.5	4.2	16.9	17.4	41.0	10.0	16.1	55.4	9.5	4.9	1.61	2.51
Cotton seed cake decorticated	11.2	7.6	38.8	9.2	19.5	13.7	31.0	18.3	12.3	1.6	2.05	3.22
Scrap. by *Goodale's process*	11.5	..	64.0	...	....	4.6	57.6	...	4.1	0.2	2.67	4.17
Fish-scrap, dry ground...	11.7	..	51.5	...	....	8.1	46.4	....	6.2	0.3	2.28	3.56
Dried blood	12.0	4.1	80.8	...	2.6	0.5	54.1	2.6	0.5	....	2.39	3.76
Whey	92.6	0.7	1.0	...	5.1	0.6	1.0	5.1	0.6	6.6	.11	.18
Milk	87.5	0.7	3.2	...	5.0	3.6	3.2	5.0	3.6	4.4	.34	.53

* Nutritive ratios are read, 1 : 10.6, 1 : 8.3, etc. See page 73.

special ratio of digestible albuminoids to digestible carbhydrates is the best and most economical, and, within certain limits, is necessary. This proportion we designate as the *nutritive ratio*, and these explanations make its significance evident.

To allow of directly comparing the money-value of feeding stuffs with some universally accepted standard, the last column of the table (page 75) gives a comparison with good average meadow hay taken as 1.

ANALYSES OF HAY.

LXI. Cut May 30, 1879, from dry upland, gravelly loam. Seeded with blue grass, white clover, timothy and red-top, and mown three years. Sent, June 27th, by A. J. Coe, West Meriden.

LXII. Cut June 5, 1879, from dry upland. Seeded with red clover. Sent by A. J. Coe.

XLVIII. Cut first week in July, 1877. From dry, rich upland, plowed about forty years ago. Consists of fine grasses. Large amount of Kentucky blue-grass (*poa pratensis*), and timothy (*phleum pratense*). Considerable red and white clover, a little red top (*agrostis*). Sent by T. S. Gold, West Cornwall.

LXVII. Yellow clover and timothy, with some *agrostis* and *poa compressa*. Cut July 1, 1877. Sent by S. A. Smith, Cheshire.

LII. Cut first week in August, 1877, from intervale meadow, sometimes overflowed. Mostly timothy and red top, some red clover and white weed (*chrysanthemum vulgare*).

LX. Timothy.* Cut June 23, 1879, from meadow never plowed. The growth was very rank, the stalks averaging 4–4½ feet high. Sent by A. J. Coe.

LVII. Cut July 1, 1878, when about one-fourth part was in bloom. Very heavy rank grass. Almost all timothy, a very little Kentucky blue-grass. From J. W. Sanborn, N. H.

* The grass of this sample was not named by Mr. Coe when sent, but at the Station was pronounced to be timothy, and was so designated in Bulletin 34. Mr. Coe believes it to have been some other grass, but the small sample was all pulverized for the analysis, and its kind must remain in doubt.

LVIII. Cut July 11, 1878. A half or more had ripened enough so that the seeds would scatter out a little in handling. The grass was of the same species as LVII.

LVII and LVIII, were both sent by J. W. Sanborn, Esq., Hanover, New Hampshire, from the Agricultural College farm, and were cut from the driest part of a fine heavy clay, yielding two, and under good culture, three to four tons of hay per acre.

LXIV. Timothy hay. The first cut after seeding. Yield 2½ tons per acre. Height, five feet. Cut July 20–25, 1877. From S. A. Smith, Cheshire.

L. Cut last week in July, 1877, from rich, moist upland. Mostly timothy. Some red-top. From T. S. Gold, W. Cornwall.

LIX. Cut June 17, from dry upland. Seeded with timothy and red-top and mown three years. From A. J. Coe, W. Meriden.

LXIII. Cut June 18, from moderately dry irrigated intervale. Seeded with timothy and red-top and mown four years. From A. J. Coe, W. Meriden.

LXIX. Timothy and red-top. Second cut from new ground. Cut July 20, 1877. From S. A. Smith, Cheshire.

LI. Cut last week in July, 1877, from moist upland. Mostly red-top and timothy. From T. S. Gold, W. Cornwall.

XLIX. Cut second week in July, 1877, from rich, moist upland. Mostly timothy and Kentucky blue-grass. Some red-top. From T. S. Gold, W. Cornwall.

LXVI. From old meadow, 1½ tons per acre, poor feed, rather run out. Cut fourth week in June, 1877. From S. A. Smith, Cheshire.

LXVIII. From old meadow in grass for 10–15 years. Cut first week in July, 1877. From S. A. Smith, Cheshire.

LIII. Cut about the middle of August, 1877, from wet lowland, sometimes overflowed. Contains a good deal of sedge grass (*carex sterilis*), and some fern. Other weeds such as *brunella vulgaris*. Very little timothy. From T. S. Gold, W. Cornwall.

LXV. Swamp hay mostly, some species of sedge (*carex*), some fern, *equisetum*, etc. "Young stock eat it and do well, old cattle used to better, don't." From S. A. Smith, Cheshire.

LV. German golden millet. Grown on gravelly loam which had received no manure for two years previous. Estimated yield 1½ tons per acre. Sent by L. S. Wells, New Britain.

LIV. Maize stover. Variety, white flint. From T. S. Gold, W. Cornwall.

In the following tables of the composition and probable digestibility of these samples, the analyses have all been reduced to a uniform water-content of 14.3 per cent. in order to render them comparable with each other, and with the average of German analyses as given on p. 75.

The digestible nutrients have been calculated from the results of the many digestion experiments made elsewhere on hays of similar composition, and while making no claim to strict accuracy suffice to give an idea of the amounts of really nutritive matters which these feeding stuffs probably contain.

Mr Gold states that the value of his samples, as judged practically, stands in about the following order: XLVIII, XLIX, L, LI, LII, LIII.

The crops were light, owing to the weather of 1877. XLVII and LIII yielded not over one ton per acre. The others yielded one and a half to two tons. All were harvested at what was regarded as the right time or stage of growth except LIII which was let stand too long. The hay was of very good quality, as compared with that of former years, but contained a less proportion of timothy.

The two samples sent by Mr. Sanborn have been employed in some interesting feeding trials, the results of which he has published.*

The six samples supplied by Mr. S. A. Smith, of Cheshire, were kindly selected by that gentleman who has had extensive experience in the purchase and sale of hay. as fair representatives of the various grades of hay raised in Cheshire. The yellow clover is, however, not common.

The samples sent by Mr. Coe were intended to exhibit the effect of "the time of cutting" on the quality of hay. Mr. Coe considered them all cut in proper time except LX which was too mature.

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* Farm Experiments at the New Hampshire College of Agriculture, by J. W. Sanborn, Superintendent.

ANAYSES OF HAY AND STOVER.

Station No.	Water.	Ash.	Total Nitrogenous Matters, Albuminoids and Amides.	Albuminoids.	*Amides.	Fiber.	N. fr. Extract.	Fat.	Sent by	When Cut.	Received at Station.
						Hay Containing Clover.					
LXI,	14.30	5.30	14.42	11.56	2.86	19.66	42.23	3.09	A. J. Coe,	May 30, 1879.	June 27, 1879.
LXII,	14.30	6.49	11.62	9.38	2.24	23.06	42.07	2.46	" "	June 5, "	" 1879.
XLVIII,	14.30	5.10	10.60	8.69	1.91	24.90	42.40	2.70	T. S. Gold.	July 1–8, 1877.	November 15, 1877.
LXVII,	14.30	4.74	9.06	7.50	1.56	28.19	42.21	1.50	S. A. Smith.	" 8–15, "	" 28, "
LII,	14.30	5.10	9.00	7.25	1.75	24.90	44.90	1.80	T. S. Gold.	August 1–8, 1877.	" 15, "
						Hay consisting mostly of Timothy.					
LX,	14.30	3.27	4.88	3.69	1.19	32.81	43.29	1.45	A. J. Coe.	June 28, 1879.	June 27, 1879.
LVII,	14.30	4.10	6.20	5.38	0.82	25.30	48.10	2.00	J. W. Sanborn.	July 1, 1878.	February 10, 1879.
LVIII,	14.30	3.80	5.30	4.75	0.55	27.50	47.20	1.90	" "	" 11, "	" 10, "
LXIV,	14.30	4.38	5.57	4.44	1.13	29.48	45.19	1.08	S. A. Smith.	July 20–25, 1877.	November 28, 1877.
L,	14.30	4.60	6.90	5.50	1.40	26.80	45.40	2.00	T. S. Gold.	" 21–28, "	" 15, "
						Hay consisting mostly of Timothy and Red-top.					
LIX,	14.30	5.57	7.85	6.69	1.16	24.72	45.08	2.48	A. J. Coe.	June 17, 1879.	June 27, 1879.
LXIII,	14.30	6.86	8.97	6.88	2.09	28.45	39.20	2.22	" "	" 18, "	" " "
LXIX,	14.30	4.81	6.02	5.31	0.71	26.54	46.88	1.45	S. A. Smith.	July 20, 1877.	November 28, 1877.
LI,	14.30	4.90	7.50	6.25	1.25	26.30	45.30	1.70	T. S. Gold.	" 21–28, 1877.	" 15, "
						Hay consisting mostly of Timothy and Blue Grass.					
XLIX,	14.30	4.70	7.00	5.56	1.44	26.90	45.40	1.70	T. S. Gold.	July 7–14, 1877.	November 15, 1877.
						Hay of mixed Meadow Grasses.					
LXVI,	14.30	4.23	7.02	6.38	0.64	27.82	45.00	1.63	S. A. Smith.	June 21–28, 1877.	November 28, 1877.
LXVIII,	14.30	4.56	6.50	5.69	0.81	25.89	47.33	1.43	" "	July 1–7, "	" " "

Station No.	Water.	Ash.	Total Nitrogenous Matters, Albuminoids and Amides.	Albuminoids.	*Amides.	Fiber.	N. fr. Extract.	Fat.	Sent by	When cut.	Received at Station.
						Swamp Hay.					
LIII,	14.30	5.40	6.70	5.69	1.01	26.20	46.10	1.30	T. S. Gold.	August 15, 1877.	November 15, 1877.
LXV,	14.30	8.56	7.27	6.31	0.96	23.22	44.49	2.16	S. A. Smith.	August 7-14, 1877.	" 28, "
						Millet.					
LV,	14.30	6.54	6.29	3.81	2.48	27.93	43.61	1.33	L. S. Wells.		October 24, 1877.
						Stover.					
LIV,	14.30	4.43	6.45	3.94	2.51	28.33	45.00	1.49	T. S. Gold.		November 20, 1877.

Averages of German Analyses.

										Quality.
	14.30	5.00	7.50	....	....	33.50	38.20	1.50	From Mentzel & v. Lengerke's *Ländw. Kalender*, for 1880.	Poor.
	14.30	5.40	9.20	....	....	29.20	39.70	2.00		Fair.
	14.30	6.20	9.70	....	....	26.30	41.40	2.50		Good (Average).
	15.00	7.00	11.70	....	....	21.90	41.60	2.80		Very good.
	16.00	7.70	13.50	....	....	19.30	40.40	3.00		Extra.

* More properly non-albuminoid nitrogenous matter.

DIGESTIBLE NUTRIENTS OF HAY AND STOVER.

Station No.	Albu-minoids.*	N. fr. Extract.	Fat.	Nutritive Ratio.	Quality.
LXI, ...	9.28	41.54	1.48	1:4 9	Extra.
LXII, ...	7.44	42.95	1.18	1:6.2	very good.
XLVIII, ...	6.78	43.35	1.30	1:7 6	Average.
LXVII, ...	5.06	42.68	0.72	1:8 8	Fair.
LII, ...	5.04	42.48	0.86	1:8.8	Average.
LX, ...	2.54	45.11	0.70	1:18.4	Poor.
LVII, ...	3.47	44.72	0.96	1:13.5	Average.
LVIII, ...	2.96	45.40	0.91	1:16.1	Fair.
LXIV, ...	2.90	44 35	0.52	1:15 7	Fair.
L, ...	3.66	43.88	0.96	1:12.6	Average.
LIX, ...	4.40	42.48	1.19	1:10.3	Average.
LXIII, ...	5.02	40.92	1 07	1: 8.6	Fair.
LXIX, ...	3.39	44.59	0.70	1:13.7	Average.
LI, ...	4.20	43.53	0.82	1:10.8	Average.
XLIX, ...	3.92	43.93	0.82	1:11.4	Average.
LXVI, ...	3.69	43.21	0.74	1:12.2	Fair.
LXVIII, ...	3.67	44.49	0.60	1:12.5	Average.
LIII, ...	3.75	43.97	0.62	1:12.1	Average.
LXV, ...	4.08	41.24	1.04	1:10.7	Average.
LV, ...	3.27	42.52	0.64	1:13.5	[Fair.]
LIV, ...	3.45	43.60	0.72	1:13.1	[Fair.]
German Averages.	3.40	34.90	0.50	1:10.6	Poor.
	4.60	36.40	0.60	1: 8.3	Fair.
	5.40	41.00	1.00	1: 8.0	Good (Average).
	7 40	41.70	1.30	1: 6.1	Very good.
	9.20	42.80	1.50	1: 5.1	Extra.

*Including, probably, all the "Amides."

It is thought by some authorities, that hay deteriorates on long keeping to a degree that affects its chemical composition. Although such a fact does not appear to be fully authenticated, it is possible that Mr. Gold's samples, which were received at the Station in November, 1877, and were analyzed eighteen months after cutting, are not as rich nutritively as when new. The same possibility of deterioration applies to the samples furnished by Mr. Smith. Mr. Sanborn's samples cannot have suffered seriously in this way from keeping. It is, however, a question whether the samples fairly represent the crops. The samples were mostly quite small and as hay, in the very brittle condition which it assumes in the driest weather of New England, easily loses some of its more tender and better parts on handling, it is possible that the care taken to select an average sample may have defeated its purpose to a serious degree.

The most obvious result of the above figures is that the New England samples are of inferior quality as compared to those of Germany and Austria which have been analyzed in the European Experiment Stations.

Only three of these New England hays, viz: LXI, LXII and XLVIII, contain more nitrogenous matters than the German average and these three contain a decided admixture of clover. Eleven out of the nineteen are below the German "poor" in this respect.

It is, however, to be remarked that the proportions of fiber in most of the New England hays are less than in the German. Not one of the former contains as much fiber as the poor German hay.

It has been observed in digestion experiments that the coarser and more woody a hay or similar fodder becomes, the less digestible it is, and that the digestibility is in a much less degree affected by a deficiency of albuminoids than by an excess of fiber, and since the grading of hay adopted by Wolff has reference mainly to the relative digestibility we are justified in the following classification of these New England hays, although the percentage of nitrogenous matters in many of the samples would give them a lower place in the scale than that here assigned to them.

Extra.	Very Good.	Average.	Fair.	Poor.
LXI.	LXII.	XLVIII.	LXVII.	LX.
		LII.	LVIII.	
		LVII.	LXIV.	
		L.	LXIII.	
		LIX.	LXVI.	
		LXIX.	[LV.]	
		LI.	[LIV.]	
		XLIX.		
		LXVIII.		
		LIII.		
		LXV.		

Whether the striking difference between these hays and those of Germany lies mainly in difference of climate, of herbage or of soil, or is attributable in part to each of these causes, further inquiry must decide.

In respect to time of cutting, the early-cut samples are in general the best; of them all, however, only two, viz: LIII and LX, were specially stated by the gentlemen who supplied them to have been harvested too late.

The two samples sent by Mr. Sanborn were used by him in a short comparative trial, the object of which was to observe their relative feeding value. This experiment is noticed on a subsequent page.

The publication of the analyses of the samples from Messrs. Gold and Sanborn and the remarks upon them in Station Bulletin 23, called forth some correspondence on the subject of early *vs.* late cutting, the substance of which here follows:

West Meriden, *Ct*, *April* 21, '79.

Prof. S. W. Johnson—Dear Sir:—In the comments appended to your recently published "Analyses of Hay," you say: "The early cut is scarcely better than the late mowed, as shown by analyses, and the feeding records give no greater actual value to the former, while the early cutting is reckoned to diminish the crop on seventy-five acres some twenty tons.

While not doubting the correctness of the first proposition in its application to the particular samples examined by you, I think most readers will draw from it an inference in regard to the proper period of growth at which to cut hay, which will be to them a most injurious error. Therefore I feel constrained to write you a few words on the subject, in hopes to promote further discussion and investigation of a matter of great importance to New England farmers.

That portion of the above quoted remark relating to loss in weight by "early" cutting purports merely to give information as you have received it, as an "estimate," without vouching for its accuracy. It is a subject upon which accurate knowledge is very desirable, but, from obvious reasons, difficult to obtain. I know of but one attempt to test by actual experiment, by weighing the hay from portions of a field cut at different stages of growth, and the conclusion of this farmer was that he got more weight of hay from timothy cut when heading than from any cut later. But, of course, in this rough experiment, there could be no accuracy as to the relative productiveness of the different plats of ground, or degree of dryness of the cured product.

But in regard to the inference from your remarks in reference to the comparative nutritive value of early and late cut hay for animals giving milk:—speaking from an experience of many years wintering twenty to forty cows in milk, and some experience with sheep suckling lambs, I should say that every sample examined by you was cut so late as to be practically spoiled for the purpose in question. Timothy is the principal grass, and I have been long satisfied that timothy cut after July 1, in this latitude should never be fed to milch animals.

I am now feeding 20 cows in milk, and 190 ewes with lamb, besides other stock, and having insufficient hay, am buying for the stock at one barn.

I buy the earliest cut I can get, the timothy not being past bloom, but had no sooner changed from my own, cut earlier, than the cows fell off most markedly in their milk, despite full feeding with grain and roots. Clover cut just after heading and before blossoming, will make more milk than any other feed, if not dried too much in the sun.

For feeding any stock whatever, I will pay more for an acre of grass, of any kind, cut about heading time, than for the same cut at any subsequent period, but especially for feeding milch animals. Animals are excellent judges of nutritive values, and if allowed access to such hay would reject any of the samples you have examined, as decisively as you would so much sticks or brushwood, and for the same reason. If you wish, I would like to present you, some time, samples of really good hay,* to ascertain whether as good cannot be made here as in Germany, and whether the results given by the chemical apparatus in your laboratory will compare with those given by that in the animal system. Very respectfully yours,

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* The samples LIX to LXII were sent by Mr. Coe subsequent to his writing the above letter.

A. J. Coe.

P. S.—I wish the method of curing by carting to the barn green, and heating in the mow, could be thoroughly tested. So far as I have tried it, I am pleased. Theoretically it would seem that there must be loss of albuminoids in the process of fermentation, but cows fed on it give a great deal of milk, consuming a comparatively small quantity.

Answer.

A. J. Coe, Esq., West Meriden:—In a letter from Mr. Sanborn, who sent the New Hampshire samples, dated April 25, he states that the loss of 20 tons total yield, on 75 acres, by early cutting, as compared with later, was accurately determined by weight and measure. He states further that the season, as a whole, was favorable to an average growth of hay. I quite agree with you that, in general, early cutting gives better hay pound for pound than late cutting. I also agree with you that all the samples reported in bulletin 23 (those of Messrs. Gold and Sanborn) were either late cut or no better than late cut, judged in respect to their quality (XLVIII possibly excepted). I agree with you also that an acre of grass cut about heading time is worth more than cut at any subsequent period. The gain of quantity got by letting grass stand after heading is more than compensated by loss of quality. Mr. Sanborn's results might appear, however, to show that under some circumstances a larger gain of quantity —20 tons on 75 acres—is attained without much loss of quality. Mr. Sanborn says "the yield of grass on 75 acres is two tons, and with good culture three to four tons per acre." The low quality fairly indicates a low yield, and if we assume the crop of July 1 to have been two tons (4000 lbs.) per acre, then the gain by growth between July 1 and July 11 being 20 tons for 75 acres, the crop of July 11 would have weighed 2$\frac{4}{15}$ tons (4,533 lbs.) per acre. Multiplying these estimated figures by the percentages of the analyses given in the Station Bulletin 23, we obtain the following average yield of food elements.

HAY FROM N. H. COLLEGE FARM.

	LVII. Cut July 1. lbs. per acre.	LVIII. Cut July 11. lbs. per acre.
Water,	572	648
Ash,	164	172
Albuminoids,	248	240
Fiber,	1012	1247
N. fr. Extract,	1924	2140
Fat,	80	86
	4000	4533

The actual yield, reported by Mr. Sanborn after the above was written, was, for the early cut, 3,444 lbs. at housing and in good order, for the late cut, 4,263 lbs. at housing. When fed, the early cut weighed 2,760 lbs., having shrunk 19.8 per cent., and the late cut weighed 3,538 lbs., having shrunk 17 per cent. The loss of crop per acre, by early cutting, was accordingly 819 lbs. at housing, and 778 lbs. at time of feeding.

Calculating from the weights observed at time of feeding, we find the actual difference greater than above supposed, viz:

	LVII. lbs. per acre.	LVIII. lbs. per acre.
Water,	247.57	328.68
Ash,	120.06	142.94
Albuminoids and amides,	181.06	199.19
Fiber,	743.82	1029.20
N. fr. Extract,	1409.53	1765.46
Fat,	57.96	72.53
	2760.00	3538.00

It is seen from the above figures that assuming a difference of 20 tons for 75 acres, as we may infer Mr. Sanborn found in gross, there has been no gain, but rather a loss of albuminoids between July 1st and 11th, a loss perhaps explained by the fact that in the later cut hay "a half or more had ripened so that the seeds would scatter out a little on handling."

Basing the calculation on the actual crops from the small plats there is found to be a loss of 18 lbs. or about 9 per cent. of albuminoids as the result of early cutting.

It is, doubtless, the fact that when the grass ripens to the point of dropping its seeds, that the crop contains, if the seeds do not drop, more nitrogen than it did ten days earlier, and a considerable part of that increase is in the seeds, but the seeds of grass are so small and hard as largely to escape mastication and digestion, and most of their nitrogen is practically lost for feeding purposes unless the feed is *cooked.*

Again it is perfectly well settled that the digestibility of albuminoids decreases as the grass grows old, and is relatively less in grass containing a low percentage of them and a high percentage of fiber.

Both the samples are deficient in digestible albuminoids, and that deficiency is in no way helped out by increase in the quantity of other substances.

In the building of a wooden house there is required a certain proportion of wood, and a certain relative quantity of nails. No amount of nails will supply a deficiency of wood, and no amount of wood can *economically* take the place of nails. For milk cows, the proportion of digestible albuminoids should compare with that of other digestible food elements, as 1 to 6, and if the proportion is 1 to 12 as in Mr. Sanborn's grass, the greater quantity of food don't help to make more milk, because the due proportion is lost. When albuminoids are deficient, their quantity limits the value of the ration.

It would thus appear from these calculations that Mr. Sanborn's crop of July 11th was not as good as or a little better than the crop of July 1st, although it weighed one quarter ton more per acre, a conclusion exactly like that which you have drawn from your experience. There is of course some uncertainty attached to calculations of this kind. Their validity implies that the samples analyzed accurately represent the crops. It is however very difficult to sample the grass from a field of many acres and the above conclusions, so far as they are based on the analyses must not be accepted too literally. Carefully conducted experiments on the composition and yield of grasses made in Germany show that there may or may not be a considerable increase in the acreage amounts of albuminoids in the harvested crops during the period between heading and ripening, depending upon the weather and the supplies of plant-food in the soil, so that the quality of grass does not always stand immediately related to the time of cutting, but is affected by other conditions which we lose sight of, or usually "lump together" in the expressions "early" and "late"

MAIZE KERNEL.

The nine samples of maize whose analyses are given below, were all raised in the towns near New Haven in 1878, were from large and well ripened ears, and represent Southern Connecticut Corn in its best development. Of these, all but two are Dent Corn; i. e., the apex of each kernel is sunken or shriveled in curing. The climate of Southern Connecticut admits of cultivating these western varieties to advantage, or rather, perhaps, developes varieties that are to a degree intermediate between the native flint and the western and southern Dent.

XXXIX. Coe's Prolific, Dent, crop of 1878. From W. W. Fowler, Guilford.

XL. Old Fashioned Yellow, Flint, crop of 1878. From Bethuel Brockett, North Haven.

XLI. Benton, Dent, crop of 1878. From G. W. Benton, Guilford.

XLII. Mammoth Sweet, crop of 1878. From S. D. Woodruff, Orange.

XLIII. Scioto, Dent, crop of 1878. From Rufus Leete, Guilford.

XLIV. White Ohio, Dent, crop of 1878. From F. Johnson, Branford.

XLV. Wisconsin, Dent, crop of 1878. From Rufus Leete, Guilford.

LXX. White Prolific, Dent, crop of 1878. From G. W. Bradley, Hamden.

LXXI. Extra Early Adams, Dent, crop of 1878. From E. B. Clark, Milford.

Analyses of Maize Kernel.

Air Dry.

	XXXIX	XL	XLI	XLII	XLIII	XLIV	XLV	LXX	LXXI
Water,........	9 55	10.58	10.70	9.43	10.45	9.70	9.72	10.14	10.94
Ash,.........	1.45	1.48	1.57	1.93	1.58	1.79	1.56	1.67	1.75
Albuminoids,..	10.13	9.81	9.97	12.32	9.25	11.28	11.60	9.19	10.81
Fiber, ...	2.19	1.39	1.36	2.75	1.80	1.73	2.06	1.34	1.48
Carbhydrates, .	72.70	72 11	71.40	66.09	72.98	71.30	70 17	73 38	70.21
Fat, ...	3.98	4.68	5.00	7.48	4.01	4.20	4.89	4.28	4.81

Weight of Corn and Cob, Cured.

Corn, weight in grams, ...	454	467	509	424	518	467	574	344	336
Cob, weight in grams, ...	98	94	84	116	78	111	103	57	89
Relation of cob to corn, ...	1:4.6	1:4.9	1:6.0	1:3.6	1:6.6	1:4.2	1:5.5	1:6.0	1:3.8
Cob express'd in per ct. of corn.	21.6	20.1	16.5	27.3	15.1	23.8	18.0	16.3	26.5

Composition of Maize Kernel.

Water-Free.

	Coe's Prolific.	Old fashioned Yellow.	Benton.	Mammoth Sweet.	Scioto.	White Ohio.	Wisconsin.	White Prolific.	Early Adams.
Ash,........	1.60	1.60	1.76	2.13	1.71	1.88	1.73	1.86	1.97
Albuminoids,	11.21	10.99	11.18	13.60	10.31	12.50	12.85	10.23	12.14
Fiber, ...	2.42	1.55	1.52	3.04	2.01	1.92	2.28	1.49	1 66
Carbhydrates	80.36	80.63	79.94	72 97	81.49	78.95	77.72	81 66	78.83
Fat, ...	4.41	5.23	5.60	8.26	4.48	4.65	5.42	4.76	5.40
	100.00	100.00	100.00	100.00	100.00	100.00	100 00	100.00	100.00

Digestible Nutrients, Etc , of Maize Kernel, in per cent. of Air Dry Substance.

Albuminoids,	9.42	9.23	9 39	11.42	8.66	10.50	10.79	7.35	8.73
Carbhydrates	78.40	76.86	75.70	69.72	77 34	74.92	73.90	66.19	68.97
Fat, ...	3.35	3.97	4.26	6.28	3.41	3.53	4.12	3.10	3.51
Nutritive Ratio,.......	1:9.2	1:9.3	1:9.2	1:7.5	1:9.9	1:7.9	1:7.8	1:10.1	1:8.3
Calculat'd val. per 100 lb.,	$1.26	1.26	1.27	1.39	1.22	1.28	1.31	1.05	1.11

The impression prevails that there are considerable differences in the quality of different varieties of Indian corn. Some of the popular ideas are certainly erroneous as will appear from the examination of the seventeen analyses made in the laboratory of this Station, thirteen executed at the Agricultural College of Michigan, under the direction of Prof. Kedzie, seven made by Dr. Atwater of Middletown, and twenty-eight by Dr. Collier, of the U. S. Department of Agriculture—a total of 65 analyses.

These analyses lead to the following conclusions, viz:

1. From the point of view of chemical composition, there are, broadly speaking, two kinds of Indian corn, the common and the sweet.

2. The average composition of these two kinds in the water-free condition is as follows:

Average Composition of American Maize.—Water-Free.

	SWEET av. of 11 analyses.	COMMON. av. of 52 analyses.
Ash,	2.1	1.7
Albuminoids,	13.2	12.0
Fiber,	2.3	1.9
Carbhydrates (starch, sugar, gum),	73.5	78.7
Fat,	8.9	5.7
	100.0	100.0

The greater richness of sweet corn in albuminoids and fat is very decided and indicates a higher nutritive value than that of common corn.

The sweet corn contained on the average 8.6 per cent. of water and the common contained 10.8 per cent., but the samples were unequally dried, and the analyses probably do not show the proportions of water that exist in corn in bulk as found in the crib or in market.

3. The range of variation in the several ingredients is shown by the following statement of the lowest and highest percentages as found in these analyses:

Range of Composition of American Maize.

	Sweet.	Common.
Ash,	1.6 — 2.4	1.3 — 2.0
Albuminoids,	10.2 — 15.9	8.7 — 14.4
Fiber,	2.6 — 3.0	0.3 — 3.0
Carbhydrates,	69.6 — 79.5	75.2 — 82.2
Fat,	5.8 — 10.2	4.4 — 7.8

Sweet corn in all the analyses contain more ash, more fat and less carbhydrates than common corn.

4. Flint and dent corns have, in the gross average, practically the same composition as will be seen from the comparison of 31 flints and 19 dents.

Average Composition of Flint and Dent Corn.

	Flint.	Dent.
Ash,	1.7	1.7
Albuminoids,	12.1	11.8
Fiber,	1.7	2.0
Carbhydrates,	78.7	79.0
Fat,	5.8	5.5
	100.00	100.00

The average water content of flint corn was found to be 10.6 per cent., that of dent corn 11.1 per cent.

5. Western corn has also, in the gross average, about the same nutritive value of Eastern corn. Below is the average composition of 29 samples of corn raised at the East, and 15 samples of corn raised at the West.

Average Composition of Common Eastern and Western Corn.

	Eastern.	Western.
Ash,	1.7	1.6
Albuminoids,	12.0	12.1
Fiber,	1.6	2.5
Carbhydrates,	79.2	78.1
Fat,	5.5	5.7
	100.0	100.0

The Eastern corn averaged 10.7 per cent. of water, and the Western 13 per cent. To institute a strict comparison any *constant difference* in water content should be taken into the account. All the foregoing comparisons refer to the perfectly-dried, or water-free corn.

It should be said here, that the popular idea that western corn is inferior to eastern corn, is probably correct, if by "western corn" is meant the corn as it comes in bulk from the west to be ground for feed.

The samples of western corn whose average composition is given above were no doubt taken from the field or barn to the laboratory, and had been properly cured and stored. But when corn is raised on a large scale for market at the west, it cannot be as carefully cured as with us. Many times it cannot be put under cover at all, but is stacked in the field, and necessarily deteriorates, from exposure to the weather. A single analysis of such corn (No. 4 of table at end of Report) made by Dr. Atwater, of Middletown, gave the following result—calculated on a water-free basis:

Ash,	1.4
Albuminoids,	10.3
Fiber,	1.9
Carbhydrates,	81 9
Fat,	4.5
	100

It will be seen that it has one and seven-tenths per cent. less albuminoids and one per cent. less fat than the average of eastern corn, and two and seven-tenths per cent. more of carbhydrates, while ash and fiber are approximately the same. Dr. Atwater says the sample contained unsound kernels, bits of cob, fine prairie soil, and other refuse.

6. Unripe maize so far as its composition is illustrated by three analyses of the same kind of sweet corn, is richest in albuminoids—the rarest and most costly element of food.

The samples of sweet corn, harvested by Mr. Gold, Aug. 9, Aug. 25 and Sept. 25, 1877, respectively, had the subjoined composition:

	Aug. 9.	Aug. 25.	Sept. 25.
Water,	10.1	10.1	9.5
Ash,	2.2	2.1	2.1
Albuminoids,	14.5	15.3	14.4
Fiber,	2.6	2.5	1.9
Carbhydrates, starch, etc.,	62.7	61.8	63.0
Fat,	7.9	8.2	9.1
	100.0	100.0	100.0

The albuminoids found in the earliest are indeed scarcely more than those of the latest corn. But the earliest cut sample was very small and immature, and was shelled from a cob that contained 8.6 per cent. of albuminoids, while the others were from cobs of 3.0 and 2.7 per cent. albuminoids, respectively. The comparison is therefore properly between the corn of Aug. 25 and that of Sept. 25.

The mature corn contains a less percentage of albuminoids than the immature, because, in the later stages of growth, starch and sugar, as well as fat (oil) are formed in the seed at a more rapid rate than albuminoids. The percentage of fat increases from 7.9 to 9.1.

7. The ripe grain, as a crop, contains absolutely more of every ingredient than the unripe. The yield of vegetable matter per acre in the three crops just instanced is not known; but the relative yield of the two later crops is as follows per 1,000 pounds of total harvest, reckoned water-free:

	Corn.	Cob.	Fodder.	Total.
August 25,	304	88	608	1,000
September 25,	356	94	550	1,000

Doubtless 1,000 pounds of the dry matter of the standing crop on Aug. 25 would have increased to 1,250 pounds, more or less, by Sept. 25, so that the acreage yield of total vegetable substance, as well as the relative proportion of grain, would increase to the time of full ripeness, while the cob and stover would increase absolutely, but not so rapidly as the grain, and relatively to grain would appear to diminish. In fact the grain increases at the expense of stover and cob as well as of roots, while the entire plant gains by growth as long as the leaves are green and unshriveled.

Hominy Chops.

LVI. Sent by C. P. Augur, Whitneyville.

LXXII. Sent by J. J. Webb, Hamden. Sold by D. B. Crittenden, New Haven.

	LVI.	LXXII.
Water,	13.58	11.56
Ash,	2.44	2.67
Albuminoids,	9.50	9.82
Fiber,	3.19	4.79
N. fr. Extract,	62.02	62.58
Fat,	9.32	8.58
	100.00	100.00

Digestible Nutrients.

	LVI.	LXXII.
Albuminoids,	7.58	8.25
Carbhydrates,	59.48	60.60
Fat,	7.08	6.52
Nutr. Ratio,	1:9.6	1:9.2
Estimated value per 100 lbs.,	$1.17	$1.19
Cost per 100 lbs.,	$1.00	$1.20

The above is evidently a bye-product of the hominy manufacture, a process which consists in coarsely crushing the kernels of white flint maize and separating the flinty parts from the mealy and soft portions. The former are nearly free from fat, and after drying constitute the hominy of the grocer, which may be preserved without alteration for a long time. The latter, including the chits and bran, probably make this "hominy chop." The large content of fat comes from the chit and from its presence this substance easily spoils and becomes rancid. The nutritive ratio and money value do not essentially differ from those of entire maize, but its softness and fineness are very favorable to ready and complete digestion.

Yaryan's New Process Linseed Meal.

LXXV. Sent by J. J. Webb, Hamden, Nov. 14, '79. Sold by John Kerley, New Haven.

Water,	10.76
Ash,	6.71
Albuminoids,	35.64
Fiber,	8.86
N. fr. Extract,	35.22
Fat,	2.81

Digestible Nutrients.

Albuminoids,	29.94
Carbhydrates,	31.02
Fat,	2.56
Nutr. Ratio,	1:1.2
Estimated value per 100 lb.,	$1.69
Cost per 100 lb.,	$1.50

This sample of linseed meal agrees closely in composition with the similar article that is common in foreign markets. It differs from the linseed meal formerly made, in the fact that the oil is much more completely removed, being reduced from 10 or more per cent. to less than 3. This reduction of oil is accompanied by a corresponding increase of albuminoids, &c.

RATIONS FOR FARM ANIMALS.

The matter of the following four pages is here reprinted because the Board of Control of the Station desires to induce our farmers to experiment on the newer modes of cattle feeding, and because the previous Reports were issued in small editions.

In the following tables of Feeding Standards from Dr. Wolff are stated the quantities and proportions of the digestible food elements which, according to the extensive experience of the German Experiment Stations, are to be given in the daily rations of farm animals in order to secure the best results of feeding. By "total organic substance" is meant the organic matter of feed considered free from water and ash. The difference between total organic substance and "total nutritive substance" expresses the quantity of indigestible or undigested matters of the ration. We are told that animals will indeed often do well with a ration less rich in albuminoids, the total amount of nutritive matters being kept up to the figures given below, but when by the use of the more highly nitrogenous feeding stuffs, such as brewer's grains, beans, peas, cotton seed cake, and meat or fish scrap, the nutritive ratio can be brought up to these standards, the results will be the most satisfactory.

The practical significance of these Feeding Standards is explained by the following paragraphs, which I have freely translated, from Dr. Wolff.

A milk cow is kept in good condition and with a full flow of milk on rich pasturage, or young clover, of which 30 lbs. are on an average daily consumed per 1,000 lbs. of live weight of improved breeds. 30 lbs. of young clover or best clover hay contain:

	Digestible.		
Organic substance.	Albuminoids.	Carbhydrates.	Fat.
23 lbs.	3.21	11.28	0.68

Experiment in the stall shows that the same result can be had with the best meadow hay, obtained from rich ground and cut young, in which 30 lbs. contain

	Digestible.		
Organic substance.	Albuminoids.	Carbhydrates.	Fat.
23.2	2.49	12.75	0.42
Feeding standard, 24	2.5	12.5	0.4

or almost exactly the quantities of the feeding standard, and 0.7 lb. less of albuminoids than in the clover.

In the winter keep of cows the hay at disposal is usually of only average or even of inferior quality and not capable alone of suitably nourishing milk cows. It is therefore necessary to add something to it in order to get a proper feed. Where hay commands a high cash price, it is often cheaper to use straw, chaff or maize fodder in combination with richer maize meal, bran, brewer's grains, cotton seed meal, etc., than to feed hay alone. By help of the tables we can calculate the kind and quantities of these various feeding stuffs which may compose a ration that shall take the place of clover hay and correspond to the feeding standard. Suppose there is on hand and at the daily disposal of the cows, for each 1,000 lbs. of live weight, 12 lbs. of meadow hay of average quality, 6 lbs. of oat straw and 20 lbs. mangolds, while 25 lbs. brewer's grains daily can be cheaply got. By use of the tables it is easy to calculate that all these materials together will give a ration coming short of the standard by half a pound of albuminoids, while by adding to it 2 lbs. of cotton seed meal, the requirements of the ration are fully met, as shown by the following figures.

Ration for Milk Cows.

	Dry organic matter.	Digestible.		
		Albuminoids.	Carbhydrates	Fat.
12 lbs. average meadow hay,	9.5	0.65	4.92	0.12
6 lbs. oat straw,...........	4.9	0.08	2.40	0.04
20 lbs. mangolds,...........	2.2	0.22	2.00	0.02
25 lbs. brewer's grains,.....	5.6	0.98	2.70	0.20
2 lbs. cotton seed meal,....	1.6	0.62	0.36	0.24
	23.8	2.55	12.38	0.62
Standard,............	24	2.5	12.5	0.4

Feeding Standards.

A.—Per Day and per 1,000 lbs. Live Weight.

	Total organic substance.	Nutritive (digestible) substances.			Total nutritive substance.	Nutritive ratio.
		Albuminoids.	Carb-hydrates.	Fat.		
	lbs.	lbs	lbs	lbs.	lbs.	lbs.
1. Oxen at rest in a stall,	17.5	0.7	8.0	0.15	8.85	1 : 1.2
2. Wool sheep, coarser breeds,	20.0	1.2	10.3	0.20	11.70	1 : 9.
" " finer breeds,	22.5	1.5	11.4	0.25	13.15	1 : 8.
3. Oxen moderately worked,	24.0	1.6	11.3	0.30	13.20	1 : 7.5
" heavily worked.	26.0	2.4	13.2	0.50	16.10	1 : 6.
4. Horses moderately worked,	22.5	1.8	11.2	0.60	13.60	1 : 7.
" heavily worked,	25.5	2.8	13.4	0.80	17.00	1 : 5.5
5. Milk cows,	24.0	2.5	12.5	0.40	15.40	1 : 5.4
6. Fattening oxen, 1st period,	27.0	2.5	15.0	0.50	18.00	1 : 6.5
" " 2d "	26.0	3.0	14.8	0.70	18.50	1 : 5.5
" " 3d "	25.0	2.7	14.8	0.60	18.10	1 : 6.0
7. Fattening sheep, 1st period,	26.0	3.0	15.2	0.50	18.70	1 : 5.5
" " 2d "	25.0	3.5	14.4	0.60	18.50	1 : 4.5
8. Fattening swine, 1st period,	36.0	5.0	27.2		32.50	1 : 5.5
" " 2d "	31.0	4.0	24.0		28.00	1 : 6.0
" " 3d "	23.5	2.7	17.5		20.20	1 : 6.5
9. Growing cattle:						
Age, months. — Average live weight per head.						
2—3 — 150 lbs.*	22.0	4.0	13.8	2.0	19.8	1 : 4.7
3—6 — 300 "	23.4	3.2	13.5	1.0	17.7	1 : 5.0
6—12 — 500 "	24.0	2.5	13.5	0.6	16.6	1 : 6.0
12—18 — 700 "	24.0	2.0	13.0	0.4	15.4	1 : 7.0
18—24 — 850 "	24.0	1.6	12.0	0.3	13.9	1 : 8.0
10. Growing sheep:						
5—6 — 56 lbs.	28.0	3.2	15.6	0.8	19.6	1 : 5.5
6—8 — 67 "	25.0	2.7	13.3	0.6	16.6	1 : 5.5
8—11 — 75 "	23.0	2.1	11.4	0.5	14.0	1 : 6.0
11—15 — 82 "	22.5	1.7	10.9	0.4	13.0	1 : 7.0
15—20 — 85 "	22.0	1.4	10.4	0.3	12.1	1 : 8.0
11. Growing fat pigs:						
2—3 — 50 lbs.	42.0	7.5	30.0		37.5	1 : 4.0
3—5 — 100 "	34.0	5.0	25.0		30.0	1 : 5.0
5—6 — 125 "	31.5	4.3	23.7		28.0	1 : 5.5
6—8 — 170 "	27.0	3.4	20.4		23.8	1 : 6.0
8—12 — 250 "	21.0	2.5	16.2		18.7	1 : 6.5

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* The German pound is equal to 1.$\frac{1}{16}$ lb. avoirdupois. The above weights are therefore to be increased $\frac{1}{16}$ to represent our weights. For practical purposes, however, this reduction will be in most cases unnecessary as the weights are but relative and approximate.

(*Feeding Standards, continued from page* 96.)

B.—Per Day and per Head.

		Total organic substance.	Nutritive (digestible) substances.			Total nutritive substance.	Nutritive ratio.
			Albuminoids.	Carbhydrates.	Fat.		
Growing cattle: Age, Months.	Average live weight. per head.	lbs.	lbs.	lbs.	lbs.	lbs.	
2—3	150 lbs....	3.3	0.6	2.1	0.30	3.00	1 : 4.7
3—6	300 "	7.0	1.0	4.1	0.30	5.40	1 : 5.0
6—12	500 "	12.0	1.3	6.8	0.30	8.40	1 : 6.0
12—18	700 "	16.8	1.4	9.1	0.28	10.78	1 : 7.0
18—24	850 "	20.4	1.4	10.3	0.26	11.96	1 : 8.0
Growing sheep:							
5—6	56 lbs.....	1.6	0.18	0.87	0.045	1.095	1 : 5.5
6—8	67 "	1.7	0.17	0.85	0.040	1.060	1 : 5.5
8—11	75 " . ..	1.7	0.16	0.85	0.037	1.047	1 : 6.0
11—15	82 "	1.8	0.14	0.89	0.032	1.062	1 : 7.0
15—20	85 "	1.9	0.12	0.88	0.025	1.047	1 : 8.0
Growing fat swine:							
2—3	50 lbs.....	2.1	0.38	1.50		1.88	1 : 4.0
3—5	100 "	3.4	0.50	2.50		3.00	1 : 5.0
5—6	125 "	3.9	0.54	2.96		3.50	1 : 5.5
6—8	170 "	4.6	0.58	3.47		4.05	1 : 6.0
8—12	250 "	5.2	0.62	4.05		4.67	1 : 6.5

I have calculated the following rations as examples of such combinations as may be made from materials in our markets. In the first ration, bulky corn fodder such as raised by Mr. Webb in 1874 (page 75) is a large ingredient. In the other, ordinary corn stalks or "stover" enters or may enter interchangeably with rye straw, since according to Wolff their nutritive value is the same, pound for pound. The use of these rations must of course finally depend upon whether the animals can be got to relish and digest them, as well as upon their cost. I have not made any computations as to the latter point, but it is easy to do so with a knowledge of the cost of the several materials used. Actual experience alone can determine whether cattle will eat these mixtures.

Rations for Milk Cows.

	Dry organic substance.	Digestible.		
		Albuminoids.	Carbhydrates	Fat
20 lbs. cured corn fodder,	13.7	0.64	8.68	0.20
5 lbs. rye straw, or stover,	4.1	0.04	1.82	0.02
6 lbs. malt sprouts,	5.0	1.16	2.70	0.10
2 lbs. cotton seed meal,	1.6	0.62	0.36	0.24
	24.4	2.46	13.56	0.56
Standard,	24	2.5	12.5	0.4

Or again,

	Dry organic substance.	Digestible.		
		Albuminoids.	Carbhydrates	Fat.
15 lbs. stover,	12.1	0.16	5.55	0.04
5 lbs. bran,	4.1	0.59	2.21	0.15
5 lbs. malt sprouts,	4.1	0.97	2.25	0.08
3 lbs. maize meal,	2.5	0.22	2.05	0.07
2 lbs. cotton seed meal,	1.6	0.62	0.36	0.24
	24.4	2.56	12.42	0.58

As already stated, the feeding standards of the foregoing tables give the results of German experience. Doubts have sometimes been expressed regarding the applicability of these results to American farm practice, and Mr. J. W. Sanborn, in his publication already referred to (Farm Experiments at the New Hampshire College of Agriculture) makes the following statement: "German investigators have learned much of the science of feeding. Their results are not before our farmers. The analyses given in these experiments and the results of feeding, aside from abundance of other data, show that we cannot rely on them for information upon which to base accurate practice in our climate and with our soil."

If this be true, it is certainly an important fact, for nearly all the knowledge of the science of feeding which we possess we owe to those same German investigators, and it therefore seems desirable to examine somewhat in detail the experiments upon which this assertion is based.

Aside from the "abundance of other data" Mr. Sanborn's conclusions rest essentially upon the results of two series of feeding trials, viz: one with early and late cut hay and one with a variety of mixed rations.

The points on which he differs from German authorities are three: 1st. The relative value of early as compared with late cut hay. 2d. The amount of food necessary to maintain or cause a slight gain by a 1000 pound steer. 3d. The significance of the nutritive ratio as an indication of the feeding value of a ration. These points we will consider in order.

The experiments on early *vs.* late cut hay (*loc. cit.* pp. 4–8) were made on two lots of two steers each, with the two kinds of hay described on p. 76 (Station Nos. LVII and LVIII). Two experiments, each extending over fourteen days, were made on each lot as follows:

Lot 1.		Lot 2.	
a. Early Hay.		*a.* Late Hay.	
Hay consumed,	570 lbs.	Hay consumed,	569 lbs.
Gain of weight,	41 "	Gain of weight,	87 "
b. Late Hay.		*b.* Early Hay.	
Hay consumed,	585 lbs.	Hay consumed,	706 lbs.
Gain of weight,	33 "	Gain of weight,	40 "

The effects of the feeding were judged of only from the live weight and general appearance of the animals.

In respect to these feeding trials there are several points that are of importance in interpreting results.

The European experience in cattle feeding has shown that *live weight* is a very unsafe criterion of the value of food for the following reasons:

1st. The contents of the alimentary canal require five and sometimes seven days before they pass from mouth to stable floor. Therefore the use of each ration or fodder under experiment should extend over a period of *a month* at least, and an interval of a week should be allowed after beginning a new ration before its effects are taken account of, in order to get the previous ration out of the way.

2d. Change of ration is very apt to disturb the animals and they require time in order to get accustomed to new feed, so that results of the first or second weeks feeding on a changed ration are often unlike those obtained later when the animals get habituated to the diet.

3d. The weight of the contents of the digestive and intestinal canal amounts, in case of horned cattle, to 12–18 per cent. of the live weight. Since the evacuations are not or may not be entirely regular, changes of live weight of a few pounds may depend entirely upon the excrements and the food, and not upon the actual animal. An animal of 600 lbs., fasting and purged may weigh 70–110 lbs. less than the same animal full of feed, and with intestines and bladder full also. The *lean* animal has the greatest percentage of intestinal and stomach contents.

It will appear, therefore, that the results of Mr. Sanborn's feeding trials scarcely justify concluding that one of the rations fed was better or worse than the other, if the live weights alone are the criteria for a judgment, since the greatest gain observed, 43½ lbs. per head, was less than might have been caused in the ways just spoken of, and since, moreover, the duration of the experiments was comparatively short.

In connection with these experiments Mr. Sanborn says, (p. 8) "It is worthy of note that I find the amount of hay required to maintain a thousand pound steer without growth or loss of weight is less than that reported by German experimenters."

Apparently this refers to the same hay as that used in the feeding trials just mentioned. It will therefore be interesting to compare the amounts of digestible matters furnished to the cattle in those experiments with the amounts found by German experiments to be necessary for maintenance.

The hays used in these trials, though deficient in albuminoids, show by their percentage of crude fiber that they are fairly entitled to rank as of average digestibility. See remarks on p. 82.

On this basis, assuming the hays to have had the same water content as the samples analyzed at the Station, we have calculated by Wolff's digestion coefficients, the quantities of digestible albuminoids, carbhydrates, and fat fed per day and head (live weight slightly over 1000 lbs.) to each lot in each period.

It will be seen that with the exception of Lot 2 on Early Cut Hay the amounts agree quite closely. Excluding this experiment, I have computed the average of the other three and have placed beside it for comparison the average of four accordant feeding trials made at the Weende Experiment Station, by Henneberg & Stohmann. These experiments were made in the most careful manner possible and yielded the figures given in the table as the amounts of digestible nutritive matters required per day to maintain a thousand pound steer without growth or loss of weight.

	Digestible.			Nutritive Ratio.
	Albuminoids.	Carbhydrates.	Fat.	
Early Hay. Lot 1. 20.40 lbs.	0.75 lbs.	9.70 lbs.	0.21 lbs.	
" " 2. 25.22 "	0.93 "	11.99 "	0.25 "	
Late Hay. Lot 1. 20.89 "	0 65 "	10.08 "	0.20 "	
" " 2. 20.32 "	0.64 "	9.76 "	0.20 "	
Average of above experiments.	0.68 lbs.	9.83 lbs.	0.20 lbs.	1 : 15.2
" " Weende "	0.51 "	7.08 "	0.34 "	1 : 15.5

The comparison is instructive. The nutritive ratio shows that the proportion of albuminoids to non-nitrogenous matters in the food of Mr. Sanborn's steers was essentially that of the rations used in the Weende experiments, but the total amounts of digestible matters in the two cases are in the ratio of about 10 : 7. In other words Mr. Sanborn's steers *ate more* (or more properly digested more) than those of the German experimenters, and as a natural result gained weight.

At this rate a daily ration of 14–15 lbs. of the same hay should suffice to maintain the animals, but more than that would probably be necessary on account of the low temperature to which the animals were exposed in Mr. Sanborn's experiments.

In another experiment by Mr. Sanborn, in which two steers were fed for 70 days on straw and corn meal, it is stated that the animals returned "ordinary gains with only 0.42 pounds of albuminoids per day," so that "an ordinary gain is made by less albuminoids than has been thought sufficient by German investigators" (pp. 25 and 26)

From the details (on page 20) it appears that the two animals received together during the 70 days

2423 lbs. of straw.
347 lbs. of corn meal

calculated, by the aid of Wolff's tables, to contain respectively 34 and 25 pounds of digestible albuminoids or in all 59 pounds; making per day and head the amount of 0 42 pounds mentioned above.

It would appear from the estimated digestibility that the straw was oat straw, which, according to Wolff, contains 1.4 per cent. of digestible albuminoids.

Now straw of all kinds is a feeding stuff of very variable composition. According to the recent tables of J. Kühn, oat straw may contain from 0.19 to 3.50 per cent. of digestible albuminoids according to soil, climate, time of cutting, etc.

It is evident, then, that while such averages as those of Wolff have their value as aids in the calculation of rations, the variations of single samples may be so great as to entirely invalidate calculations made on the assumption of average composition. Suppose, for example, that the straw used by Mr. Sanborn was unusually rich in albuminoids, containing 2.3 per cent. in a digestible form. The result then would be as follows:

	Digestible Albuminoids.
2423 lbs. straw, - - - - -	55.73 lbs.
347 " corn meal, - - - -	25.00 "
	80.73 "
Or per day and head, - - - -	0.58 "

This with the digestible non-nitrogenous matters gives a ration somewhat richer in albuminoids and considerably so in carbhydrates than that required for maintenance according to the Weende experiments.

It is, of course, impossible to say how much the composition of the straw used varied from the average, but it is sufficient for the present purpose to point out the fact that such conclusions as that which we are here discussing require a more certain basis than is afforded by assumptions as to the composition and digestibility of the feeding-stuffs used.

In regard to nutritive ratios, Mr. Sanborn says (p. 22), "A study of the ratio of albuminoids to carbhydrates does not seem to give any pronounced indications."

Subsequently (p. 25), he says, "This appears to be true so far as the nutritive ratio is concerned, but when the absolute amounts of albuminoids and carbhydrates consumed per day per steer are considered, the indications of the table are more pronounced; the gain of steers following more closely the increase or decrease of carbhydrates, and is apparently nearly independent of the supply of albuminoids."

The general result of German experience in feeding has been to illustrate the great importance of albuminoids in animal nutrition, and to show that a liberal supply of these substances is essential to a rapid formation of flesh, fat, milk, etc. On the other hand, however, it has shown that if too much albuminoids be fed, there is a waste of these costly bodies and also that with a given amount of albuminoids in the daily ration the more non-nitrogenous nutrients the animal can be made to digest, the more albuminoids and fat are protected from destruction and made available for productive purposes. Obviously this implies a limitation of the nutritive ratio in both directions. If it be too narrow, there are not enough non-nitrogenous matters to protect the albuminoids from waste, while if it be too wide, the amount of food which the animal can eat will not contain albuminoids enough to supply the demands of the body. In most cases, however, and in fattening especially, the widest nutritive ratio consistent with the supply of the requisite albuminoids gives the best results.

It is quite natural, then, that the gain of weight in these experiments should appear to follow the increase or decrease of the carbhydrates to a certain extent. At the same time there are not wanting in the results, indications of the effect of the albuminoids, while the very variable amounts of total nutritive matters fed in the several experiments render a strict comparison impossible.

It may be added here in regard to ration 3, calculated to contain only 0.42 pounds of albuminoids, that it is not impossible that even this small amount of albuminoids in combination with the large amount of carbhydrates (9.07 lbs. against 7.03 lbs. in the Weende experiments) might suffice for maintenance at least.

The foregoing criticisms are offered with the single object of furthering investigation and with a full appreciation of the credit due Mr. Sanborn for his careful and laborious experiments, and for the truly scientific spirit with which he has sought to enlarge our knowledge.

In conclusion we should repeat in regard to these feeding-standards that they are not put forth as receipts which may be blindly followed with the certainty of a favorable result.

They are simply the results of experience and like all such results are subject to modification both by the exigencies of particular cases and by the results of further experience.

The German experimenters do not themselves imagine that they have by any means overcome the difficulties of the subject. Their results are simply the best they can offer after twenty-five years of arduous labor, after making thousands of analyses and hundreds of laborious feeding trials. They believe that they are using the right methods, but admit that many further experiments must be undertaken before the investigation can be closed. In fact they are experimenting to-day more industriously than ever, with the object to test and sift the theories which their past experience has led them to adopt, and to gain a nearer approach to the true science and best practice of cattle feeding. It is to be anticipated that their views will materially change as further knowledge is gained.

THE DETERMINATION OF ALBUMINOIDS IN FEEDING-STUFFS.

BY DR. H. P. ARMSBY.

It will be gathered from the remarks on page 73 that the albuminoids form an exceedingly important portion of the food of animals, and when we add to this the facts that they are the most costly of all the nutrients and are contained in comparatively small quantities in most feeding-stuffs we shall easily perceive how important it is to be able accurately to estimate their amount.

Unfortunately, this is a task of great difficulty. All attempts to separate the albuminoids from the other substances with which they are associated in plants and to obtain them in a weighable form have encountered two, as yet insuperable, difficulties; in the first place it has been found impossible to effect a complete separation of these bodies from the woody fiber and other substances of the plant, and in the second place all the reagents thus far employed to effect this separation have altered more or less the albuminoids themselves.

We are thus forced to make use of an indirect method.

All the albuminoids contain nitrogen as a characteristic ingredient and vary but little in composition, containing, on the average about 16 per cent. of this element. If, therefore, in a feeding-stuff containing only albuminoids and substances free from nitrogen, we estimate the amount of the latter and multiply it by 6¼ (16×6¼ = 100) we shall have a close approximation to the quantity of albuminoids present.

It is in this manner that the albuminoids in feeding-stuffs have usually been determined, it being assumed that no considerable amount of nitrogenous bodies other than albuminoids was present.

It is obvious that such a method cannot give strictly accurate results, but until within a few years the error involved has been generally considered to be comparatively small. Recently, however, the correctness of the method, and consequently the reliableness of the results of feeding experiments in which it has been used and of the estimates, partly based on it, of the value of fodders, have been seriously questioned by eminent authorities, while in less informed circles the doubt has grown into a disposition to reject all analysis of feeding-stuffs as worthless.

In view of the importance of the matter, both scientifically and practically, it seems desirable to ascertain, if possible, the amount of error incident to the present mode of determining albuminoids and the extent to which it affects the important practical results which have been obtained by its aid in the department of cattle-feeding, and also to consider the character of those methods which have been proposed as a substitute for the present one.

This implies an examination of the correctness of the two assumptions on which the usual method is based, viz., that all the albuminoids contain 16 per cent. of nitrogen and that no other nitrogenous bodies are present in feeding-stuffs. In doing this, special reference will be had to the feeding of our domestic herbivorous animals and therefore only the vegetable albuminoids will be considered.

Percentage of Nitrogen in Albuminoids.—Our most reliable knowledge of the vegetable albuminoids is due to the laborious investigations of Ritthausen,* and without going further into the literature of the subject, his results suffice to show that these bodies vary not inconsiderably in composition.

For example, in the five different albuminoids prepared by him from wheat the nitrogen ranged from 16.25 per cent. to 18.31 per cent., while in all the albuminoids examined the range was 14.71 per cent. to 18.37 per cent. He also found that albuminoids apparently identical possessed a different composition according to the source from whence they were obtained.

Ritthausen's examinations cover only the cereal grains, legumes, and oil seeds; of the albuminoids of the great number of other substances used as fodder, and especially of the albuminoids of the common coarse fodders, we have little or no knowledge. While, therefore, his results show that the assumption of 16 per cent. of nitrogen in all albuminoids is far from being correct in all cases, they also show the impossibility of finding any factor for the conversion of nitrogen into albuminoids other than a purely conventional one.

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* "*Die Eiweisskörper der Getreidearten, Hülsenfrüchte und Oelsamen.*" 1872.

It is possible that, in time, we may be able to assign different factors to the several classes of feeding-stuffs, according as one or the other albuminoid predominates, but, as yet, this is impossible, and until we possess more information regarding the albuminoids of many vegetable products than we have at present, the best that can be done is to use the ordinary factor, 6.25, bearing in mind that it is simply conventional and is only approximately true.

Non-albuminoid Nitrogenous Substances.—In addition to the albuminoids the following classes of nitrogenous substances have been found in plants:

1. Nitrates, nitrites, and ammonia salts.
2. Nitrogenous glucosides.
3. Peptones.
4. Alkaloids.
5. Amide-like bodies.

Of these, the first class occurs somewhat abundantly in beets and other root-crops and considerable quantities of nitrates are sometimes found in maize fodder. These bodies are, however, easily detected, if present, and their amount can be readily determined.

Of the remaining four groups, only the amide-like bodies have yet been found to any large extent in the ordinary feeding-stuffs and to them we shall devote most of our attention in this discussion.

By amides the chemist understands substances which bear a certain likeness to ammonia and contain a portion of an ammonia molecule in combination with an organic substance. They may be subdivided into three groups, viz., amines, amides, and amido-acids, but for convenience we may designate them collectively as amides.

They are generally well defined, crystalline bodies, soluble in water and easily passing through a moist membrane by the process of liquid diffusion, differing in these points from the albuminoids, most of which are but slightly or not at all soluble in water, are not crystalline, and diffuse with extreme slowness.

Functions of Amides in the Plant.—The first substance of this class which was discovered is asparagin, which was found by Vauquelin & Robinet in 1805, in young shoots of asparagus.

The investigations of Pfeffer* into the functions of this body in the plant, show that asparagin is produced from the albuminoids of certain seeds during germination. Being soluble in water and diffusible, it passes from the seed into the young plant and there is reconverted into albuminoids, and in this way the comparatively insoluble nitrogenous matters of the seed are transferred to the young plant where they are needed. Pfeffer experimented on germinating seeds of leguminous plants and showed that, while the albuminoids were transferred to the young plant in the way just described, they may also pass unchanged from seed to sprout.

Later researches have shown that the presence of carbhydrates is necessary for the reconversion of asparagin into albuminoids, while exposure to sunlight is not essential.

Finally, the recent investigations of Borodin† and E. Schulze‡ have rendered it at least very probable that nearly all the movement of albuminoids in the plant is effected by a formation of amides of one sort or another and a rebuilding of albuminoids from them.

Another function of amides, in certain cases, is that of a reserve of nitrogenous food.

Schulze & Urich,§ who were the first to make a thorough investigation of the nitrogenous constituents of fodder beets, showed that these roots contain comparatively large amounts of amides, which, in the second year's growth, are transferred to the sprout and converted into albuminoids, thus playing a part in the economy of the plant similar to that of the albuminoids stored up in the seeds.

Separation of Amides from Albuminoids.—In the analysis of feeding-stuffs it is desirable to estimate separately the albuminoid and non-albuminoid nitrogen. In this way, by multiplying the albuminoid nitrogen by 6¼ we obtain at least a closer approximation to the true amount of albuminoids than is possible by the ordinary method.

The several processes which have been proposed to effect this may be divided into two classes, viz., those which aim at an estimation of the albuminoid nitrogen and those which are intended to effect a determination of the amide nitrogen. Both classes assume as their starting point that all the non-albuminoid nitrogenous substances are soluble in water or acid liquids. Now, while this is true of all the bodies of this class known to exist in feeding-stuffs, and while it is very probably correct, it should be borne in mind that it is not proved. There is no reason in the nature of things why a plant should not contain an insoluble amide as well as an insoluble albuminoid.

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* *Jahrb. f. Wiss. Botanik*, VIII, 530.

† *Biedermann's Central-Blatt. Jarg.* 8, *p.* 357.

‡ *Landw. Jahrbücher*, VII, 411.

§ *Versuchs-Stationen*, XVIII, 296, and XX, 193 and 214.

If there be such, however, we have no means of ascertaining the fact at present and can only adopt provisionally the assumption just mentioned as a working hypothesis.

Taking this as a starting point, the methods of the first class proceed in general as follows.

The substance to be examined is first boiled with water slightly acidified with some organic acid or with water alone; this process dissolves out the non-albuminoid nitrogenous matters (with the reservation made above), while most or all of the albuminoids are either not dissolved at all or are coagulated by boiling. Some substance is then added to the liquid which will precipitate any dissolved albuminoids which it may still contain, without affecting the amides, etc., the mass is filtered, and a nitrogen determination made either in the insoluble matters or in the filtrate.

In the first case we get directly the albuminoid nitrogen, in the second case it is obtained by subtracting the nitrogen of the filtrate from the total nitrogen of the substance. The several methods differ essentially only in the precipitant employed. Church* recommends a 4 per cent. solution of carbolic acid, Sestini† uses lead acetate, Dehmel‡ has obtained concordant results by the use of copper sulphate as proposed by Ritthausen, E. Schulze§ proposes the use of ferric acetate as recommended by Hoppe-Seyler, while in some experiments on hay made in the laboratory of this Station, pure water has proved equally efficient. These experiments were made on three samples of hay (Nos. LIX, LX and LXI) whose analyses have already been reported.

Carbolic acid, lead acetate, and cupric sulphate were all used as precipitants and trials were also made with water alone.

* Laboratory Guide, 4th Ed., p. 209.

† *Landw. Versuchs-Stationen*, XXIII, 305.

‡ Same XXIV, 214.

§ *Landw. Jahrbücher*, VI, 160.

The experiments with carbolic acid and lead acetate were made according to the directions of Church and Sestini respectively. In the experiments with cupric sulphate the substance was boiled for an hour with water, then 10 c. c. of a ten per cent. solution of cupric sulphate were added, the boiling continued for a few minutes, the mass then filtered, and the nitrogen of the insoluble residue determined.

In the trials with water the substance was simply boiled for an hour with water slightly acidified with lactic acid, filtered, and treated as in the other methods. In each trial 0.5 grammes of hay was used, and every result is the mean of two accordant determinations.

The results express nitrogen and not albuminoids.

	LIX.		LX.		LXI.	
Water, - · -	11 31	per cent.	10.75	per cent.	11.19	per cent.
Total nitrogen, - -	1.80	"	0.81	"	2.39	"
Albuminoid nitrogen,						
By Church's method, -	1.22	"	0.68	"	1.98	"
" Sestini's " -	1.18	"	0.62	"	1.68	"
" Copper sulphate method,	1.22	"	0.69	"	1.89	"
" extraction with water,	1.11	"	0.61	"	1.92	"
Average,	1.18	"	0.65	"	1.89	"
Non-Albuminoid nitrogen, -	0.12	"	0.16	"	0.50	"

In all cases (except in Church's method, where it is impossible) the filtrate was tested for albuminoids by Millon's reagent and found to be free from them.

These results show:

First, that these samples of hay contained a considerable proportion of non-albuminoid nitrogen.

Second, that all four of the methods used for the determination of albuminoid nitrogen gave practically the same result, and that consequently the use of any reagent to precipitate dissolved albuminoids was unnecessary in these cases.

In addition to these experiments the albuminoid nitrogen in twenty-one samples of hay and stover has been determined by treatment with water in the manner described above and in no case could albuminoids be detected in the filtrate, so that we are justified in concluding that in the analysis of hay a separation of the albuminoid and non-albuminoid nitrogen may be effected most simply by means of boiling water. That this method is preferable to the use of precipitants is obvious, since we are largely ignorant of the nature of the amides and other bodies extracted by water and run the risk of precipitating them from the solution by means of the reagents intended to effect the removal of albuminoids.

Whether the method of extraction with boiling water is applicable to all feeding-stuffs is perhaps doubtful. Some experiments on rye-bran and malt sprouts seem to indicate that it is not. But to hay at least it is perfectly applicable and by its aid it is a very simple matter to determine the amount of albuminoid nitrogen present, and by multiplication by 6¼ to calculate approximately the amount of albuminoids.

For the determination of the nature of the non-albuminoid nitrogenous matters when present, we have as yet only one method, viz., that of Sachsse* for the determination of amides, which, with the modifications proposed by E. Schulze† is of great value.

It is based upon the behavior of the amides with nitrous acid. An extract of the substance, freed as far as possible from albuminoids, is brought in contact with fuming nitric acid (nitric acid containing nitrous acid) in a suitable apparatus. The nitrogen of the amides is set free together with an equal amount coming from the nitrous acid. This gas is collected and after being purified is measured. One half of it represents the amount of amide nitrogen present.

Our efforts to apply this method to the hays experimented upon were not, however, attended with success. Test analyses with pure amides gave tolerably satisfactory results, but on hay more nitrogen was usually obtained than was present in the extract experimented upon. This fact, which does not appear to have been observed before, indicates a reduction of the nitric acid by the organic matter of the extract, but only further experiments can decide definitely upon the cause.

Occurrence of Amides.—The statements just made respecting the functions of amides in the plant would lead us to expect to find them chiefly in those plants or parts of plants where growth was going on, while in those which had reached their full development we should anticipate finding most or all of the amides reconverted into albuminoids except in cases where, as in the beet, they act as a reserve of nitrogenous food. As a matter of fact those investigations which have hitherto been made confirm, in the main, these anticipations.

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* "*Chemie und Physiologie der Farbstoffe, etc.*" 1877. p. 258.

† *Landw. Versuchs-Stationen*, XX, 117.

Kellner* has made quite extensive investigations into the nature of the nitrogenous bodies of several kinds of grass and hay in various stages of growth, and has found that in one case as much as 38.5 per cent. of the total nitrogen of the substance investigated existed in some form other than albuminoids, and mostly as amides.

His results also show that in general the proportion of non-albuminoid nitrogen is greatest in young plants and decreases as they approach ripeness. An interesting difference was observed in this respect between the common grasses (*Gramineae*) and the legumes; in the former the decrease in the amount of amide nitrogen with approaching ripeness was very marked, while in the latter it was much less noticeable. The former are plants which, after flowering cease to assimilate to any great extent, while the latter, along with the formation of flower and fruit, continue to grow and assimilate food and thus offer the conditions for the formation of amide compounds.

The following table of a few of his results will serve to illustrate the facts last stated, and to give an idea of the extent to which these bodies occur in this class of feeding-stuffs.

	Total Nitrogen per ct.*	Non-albuminoid Nitrogen.		Amide Nitrogen. (Sachsse's Method.) per ct.*
		per ct.*	per ct. of total Nitrogen	
Lucerne.				
1. Cut April 7, 1½ in. high,	6.922	2.183	30.5	....
2. " " 12, 8½ in. high,	5.760	2.042	35.5	..
3. 2d Cut, without flower buds,	3.570	1.183	33.1	1.025
4. Before flowering, 18½ in. high,	2.474	0.721	29.1	0.618
5. In flower, 22½ in. high,	3.008	0.729	24.2	0.687
Red Clover.				
1. Cut March 27, 1½ in. high,	5.200	1.958	37.7	....
2. Cut Apr. 27, 2½ in. high,	3.974	0.975	24.5	....
3. In full flower,	2.244	....	(16.5)	0.370
Meadow Hay, 1877.				
1. Cut May 14,	2.824	0.983	34.8	0.892
2. " June 9,	1.787	0.285	16.0	0.239
3. " " 29,	1.354	0.102	7.5	0.083

*Per cent. of water-free substance.

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* *Landw. Jahrbücher*, VIII. I Supplement, p. 248.

In the twenty-one samples of coarse fodder analyzed at the station during the past year the percentage of true albuminoids and of non albuminoid nitrogenous matters has been determined by the process described on p. 109, with the following results.

Station Number.	Kind of Fodder.	Total Nitrogen.†	Albuminoid Nitrogen.†	Amide Nitrogen.†	Amide Nitrogen in per cent. of Total Nitrogen.
LXI,	Hay.	2.31 pr ct.	1.85 pr ct.	0.46 pr ct.	19.91 pr ct.
LXII,	"	1.76 "	1.50 "	0.36 "	19.35 "
XLVIII,	"	1.70 "	1.39 "	0.31 "	18.24 "
LXVII,	"	1.45 "	1.20 "	0.25 "	17.24 "
LII,	"	1 44 "	1.16 "	0.28 "	19.44 "
LX,	"	0.78 "	0.59 "	0.19 "	24.36 "
LVIII,	"	0.99 "	0.86‡ "	0.13 "	13.13 "
LVIII,	"	0.85 "	0.76‡ "	0.09 "	10 59 "
LXIV,	"	0 95 "	0.77 "	0.18 "	18.95 "
L.	"	1.10 "	0.88 "	0.22 "	20.00 "
LIX,	"	1.26 "	1.07 "	0.19 "	15.08 "
LXIII,	"	1.43 "	1.10 "	0.33 "	23.08 "
LXIX,	"	0.96 "	0.85 "	0.11 "	11.46 "
LI,	"	1.20 "	1.00 "	0.20 "	16.67 "
XLIX,	"	1.12 "	0.89 "	0.23 "	20.54 "
LXVI,	"	1.12 "	1.02 "	0.10 "	8 93 "
LXVIII,	"	1.04 "	0.91 "	0 13 "	12.50 "
LIII,	"	1.07 "	0.91 "	0.16 "	14.95 "
LXV,	"	1.16 "	1.01 "	0.15 "	12.93 "
LV,	Millet.	1.01 "	0.61 "	0.40 "	39.60 "
LIV,	Stover.	1.03 "	0.63 "	0.40 "	38.83 "

† Calculated on an average water-content of 14 8 per cent
‡ By Sestini's method.

Other kinds of coarse fodder than those enumerated above have not yet been tested for amides.

Of concentrated fodders there is but one in common use in which the foregoing considerations would lead us to expect any large amount of amides, viz., malt sprouts or "screenings." This consists of the sprouts formed in the preparation of malt, and separated from it in the subsequent drying, and has been found to be quite rich in amides. E. Schulze* states that Stein has found them very rich in soluble nitrogen compounds and that asparagin has been found in them by Lermer. A sample of malt sprouts has also been examined in the laboratory of the Station for amides. The methods of Sestini and of Church were both used; the results did not show a satisfactory agreement, but the presence of a considerable amount of amide-like bodies was proved. The results were as follows:

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* *Landw. Jahrb.*, VI, 171.

Total Nitrogen, - - - - -	4.53 per cent.
Albuminoid nitrogen,	
By Sestini's method, - - - -	2.60 "
" Church's " - - - - -	2.88 "
Non-albuminoid nitrogen, - - - -	1.65–1.93 per cent.

A trial by Sachsse's method showed the presence of amides, but a satisfactory determination of their quantity was not obtained.

Five samples of malt sprouts examined by Kellner* gave by Sachsse's method, the following results, on tho water-free substance:

	Total Nitrogen.	Amide Nitrogen.	Albuminoid Nitrogen.
No. 1,	3.556 per cent.	0.822 per cent.	2.734 per cent.
" 2,	4.213 "	1.023 "	3.190 "
" 3,	4.479 "	1.606 "	2.873 "
" 4,	5.030 "	1.414 "	3.616 "
" 5,	5.520 "	1.418 "	4.102 "

Other concentrated fodders, especially the grains and their bye-products, have usually been assumed to contain no amides, but some recent results serve at least to show the need of further investigation. Thus Sachsse† found in the aqueous extract of peas a small quantity of nitrogen apparently belonging to amide-like compounds, and Schulze and Umlauft‡ found in the seeds of the yellow lupine 1.30 per cent. of nitrogen not in the form of albuminoids, much of which existed as amides. A sample of rye-bran examined in the Station laboratory by the same methods used on malt sprouts gave:

Total nitrogen, - - -	2.69 per cent.
Albuminoid nitrogen,	
By Sestini's method - -	2.09 "
" Church's " - - -	2.28 "
Non-albuminoid nitrogen, -	0.41–0.60 per cent.

The agreement between the two methods is not very close and the experiments were not in all respects as satisfactory as could be desired, but they plainly indicate the presence of some other nitrogenous substances than albuminoids.

A single determination on a sample of wheat bran by Sestini's method gave the following results:

Total nitrogen, - - - - -	2.82 per cent.
Albuminoid nitrogen, - - - - -	1.99 "

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* *Biedermann's Central-Blatt. Jarg.* 3. p. 417.

† *Landw. Versuchs-Stationen*, XVII, 31.

‡ *Landw. Jahrbücher*, V, 836.

A sample of "hominy chops" (Station number LVI) gave by Sestini's method:

Total nitrogen, - - - - - -	1.52
Albuminoid nitrogen, - - - - -	1.44 per cent.

a difference less than the possible errors of experiment.

Quite recently Wigner* reports having found by Church's method that a small proportion of the nitrogen of cereal grains and a large proportion of that of cocoa belongs to non-albuminoid compounds. Finally, Dehmel (*loc. cit.*) found by the copper sulphate method the following quantities of albuminoid nitrogen in lupines and beans:

	Lupines.	Beans.
Albuminoid nitrogen, - - -	7.01 per cent.	4.10 per cent.
Non-albuminoid " - - -	0.51 "	0.68 "

He also shows that this method when applied to potatoes gives too high results for the albuminoid nitrogen, owing probably to the formation of a difficultly soluble compound of some of the "amides" with copper.

As already stated, large quantities of amides have been found in root-crops.

Various experimenters have noticed the occurrence of amides or related bodies, as well as of nitrates and ammonia salts, in beets, but the first thorough investigation of the nitrogenous constituents of fodder beets are those of Schulze and Urich already alluded to. In their first investigation† they confirmed the fact that beets contain a relatively large but variable quantity of nitrates, and also found a very considerable quantity of amides, while only 21.6–38.9 per cent. of the total nitrogen belonged to albuminoids.

The following statement of their results on one sample will serve to give an idea of all.

	Per cent of fresh substance.	Per cent of total Nitrogen.
Total nitrogen, - - -	0.2390	100.00
Nitrogen in soluble albuminoids - -	0.0358	14 98
" insoluble " - -	0.0158	6.61
" amides, - - - -	0.0857	35.86
" nitrates, - - - -	0.1053	44.06
" ammonia salts, - -	0.0050	2.09
	.2476	103 60
Error - - - - -	.0086	3.60

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* *Jour. Chem. Soc.*, 1879, pp. 486 and 498.

† *Landw. Versuchs-Stationen*, XVIII, 296.

The amide nitrogen was determined by treating the juice, after having freed it from albuminoids, directly with nitrous acid, one half of the resulting nitrogen being considered as coming from the material under investigation. No asparagin could be detected.

In their second paper* the same authors show that among the amide-like bodies contained in beets was glutamine and a trifling amount of asparagin. They also investigated the functions of the amides, with the results already stated.

A considerable amount of non-albuminoid nitrogen has also been found in the potato by Schulze and Mercker† and by Kreusler,‡ and more recently Schulze and Barbieri § have published more extended investigations of five sorts of potatoes which showed that the nitrogen of the fresh substance was distributed as follows:

	Nitrogen of Insoluble Albuminoids.	Nitrogen of Soluble Albuminoids.	Nitrogen of Amides.
I.	0.069 per cent.	0.143 per cent.	0.125 per cent.
II.	0.046 "	0.157 "	0.118 "
III.	0.058 "	0.080 "	0.143 "
IV.	0.047 "	0.155 "	0.150 "
V.	0.087 "	0.147 "	0.100 "

The distribution of the nitrogen between albuminoids and non-albuminoids was, therefore:

	Albuminoids.	Non-Albuminoids.
I.	60.7 per cent.	39.3 per cent.
II,	59.7 "	40.3 "
III,	47.4 "	52.6 "
IV,	48.2 "	51.8 "
V,	65.2 "	34.8 "

Beets and potatoes appear to be the only root-crops whose nitrogenous constituents have been investigated, but it is highly probable that other roots and tubers also contain considerable amounts of amides. Naturally the bye-products such as "potato slump," beet-root molasses, etc., are also liable to contain the same or derived bodies.

Nutritive Value of Amides.—In view of the wide-spread occurrence of nitrogenous bodies not belonging to the albuminoid group the question of their nutritive value becomes an important one. Not only is it an element which must enter into our estimates of the value of feeding-stuffs, but it is one which may materially modify the conclusions to be drawn from the results of feeding experiments.

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* *Landw. Versuchs-Stationen*, XX, 193.

† *Jour. f Landw.*, 1872, p. 66.

‡ See the paper by Schulze and Barbieri.

§ *Landw. Versuchs-Stationen*, XXI, 63.

Until very recently the presence of these bodies has not been considered or even recognized in the analysis of feeding-stuffs, and in many feeding experiments, from whose results important conclusions have been drawn as to the amounts of the various nutrients required in the food of farm animals, fodders have been used which have since been shown to contain considerable quantities of amide-like bodies.

Obviously, then, it is very desirable that we should know what nutritive effect, if any, these substances exerted in these experiments.

We shall confine our attention to the amides, since these are the only non-albuminoid nitrogenous matters which have been experimented with.

It may safely be assumed that these comparatively simple bodies cannot perform all the functions of the complex albuminoids, but it would seem that certain authors have allowed themselves to be carried too far by purely speculative considerations when they have pronounced them valueless for animal nutrition.

Amides are decomposed in the Body.—It has been shown by various investigators that some amides, at least, when introduced into the stomach, are resorbed and take part in the chemical changes in the body. Schultzen and Nencki* were among the first to investigate this subject. They experimented on a dog with acetamide, glycocol, leucin, and tyrosin and found that all except the first were decomposed in the body and caused an increased excretion of urea, the normal product of the destruction of nitrogenous matters in the body.

Their experiments were not adapted nor intended to show the nutritive value of amides, but it may be noted in passing that all their experiments seem to show a retention by the body of nearly 25 per cent. of the nitrogen of the amide and thus to indicate that a gain of flesh took place under its influence.† The results, however, are not decisive on this point.

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* *Zeitschrift f. Biologie*, VIII, 124.

† Nitrogen is the characteristic ingredient of the albuminoids, the materials which, together with water and salts, compose flesh, and hence when the body of an animal receives more nitrogen than it excretes, we conclude that it has gained an amount of flesh corresponding to the difference.

Similar experiments, also on a dog, by v. Knieriem[*] with asparaginic acid and asparagin gave essentially the same result. They showed that these substances are converted into urea in the body and showed also a retention in the body of 9–10 per cent. of the amide nitrogen fed.

Further experiments by the same author[†] on hens with asparagin, asparaginic acid, glycocol, and leucin confirmed his previous results. In no case was there any indication of an increase of the amount of albuminoids oxydized in the body under the influence of the amides.

Indications of Nutritive Value.—All these results, while highly interesting, leave the question of the nutritive value of amides still in doubt. There are many facts, however, which indicate that they may have a certain value as food. The fact that they are decomposed in the body is one. Another is that they are formed from the albuminoids of the food to a considerable extent by the action of the trypsin of the pancreatic juice during digestion. It seems hardly probable that the amides thus formed are to be regarded as waste products.

Moreover, we have seen that in the plant these bodies may serve as a source of albuminoids, and while such synthetic processes are particularly characteristic of vegetable life, they are by no means excluded in the animal organism.

The not improbable conjecture has been advanced that amides in the food may play the same part in nutrition as gelatin has been shown to perform by Voit and others, viz., be oxydized in the place of a portion of the albuminoids, thus leaving the latter available for the formation of flesh or for other productive purposes.

This conjecture seems to be sustained by the experiments about to be described.

Asparagin a Nutrient.—The only experiments as yet executed for the purpose of determining the nutritive value of amides are those of Weiske, Schrodt, and v. Dangel[‡] at the Proskau Experiment Station with asparagin. Experiments on rabbits and on hens having shown only that albuminoids could not be entirely replaced by asparagin, but giving in other respects indecisive results, a third series was made on two merino southdown sheep.

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[*] *Zeitschrift f. Biologie*, X, 279.

[†] *Zeitschrift f. Biologie*, XIII, 36.

[‡] *Zeitschrift für Biologie*, XV, 261.

The plan of the investigation was as follows:

The animals were fed at first with a fodder poor in albuminoids. Then, in three following periods, the amount of nitrogen in the daily ration was doubled by the addition respectively of albuminoids (in the form of peas), gelatin, and asparagin, while the amount of the non-nitrogenous nutrients was kept practically the same. These additions to the original fodder were made in the opposite order with the two animals, in order that the nutritive effect of the asparagin on each sheep might be compared with that of albuminoids on the other, and the influence of any individual peculiarities be thus eliminated.

In the statement of the results which follows, the numbers represent the average per day and head for five days.

Period I.

Ration. Sheep I and II, 500 grms. of hay. 200 grms. starch. 50 grms. sugar.

	Albuminoids digested.	Carbhydrates digested.	Fat digested.	Nitrogen of urine.	Flesh gained.
Sheep I,	22.21 grms.	412.37 grms	9.89 grms.	3.275 grms.	8.34 grms.
" II,	22.86 "	412.71 "	9.67 "	3.388 "	0.45 "

Period II.

Ration.
Sheep I, 500 grms. hay. 200 grms. starch. 50 grms. sugar. 42 grms. asparagin.
" II, " " " 80 " " 20 " " 250 " peas.

	Albuminoids digested.	Carbhydrates digested.	Fat digested.	Nitrogen of urine.	Flesh gained.
Sheep I,	70.86* grms.	411.25 grms.	9.87 grams.	9.958 grms.	41.23 grms.
" II,	83.54 "	427.49 "	14.08 "	11.099 "	72.51 "

Period III.

Ration. Sheep I and II,
500 grms. hay. 200 grms. starch. 50 grms. sugar. 53 grms. gelatin.

	Albuminoids digested.	Carbhydrates digested.	Fat. digested.	Nitrogen of urine.	Flesh gained.
Sheep I,	66.68* grms.	399.71 grms.	9.28 grms.	8.69 grms.	59.15 grms.
" II,	66.38* "	401.52 "	8.86 "	9.95 "	20.32 "

Period IV.

Ration.
Sheep I, 500 grms. hay. 115 grms. starch. 15 grms. sugar. 200 grms. peas.
" II, " " " 200 " " 50 " " 53 " asparagin.

	Albuminoids digested.	Carbhydrates digested.	Fat digested.	Nitrogen of urine.	Flesh gained.
Sheep I,	71.24 grms.	441.17 grms.	13 34 grms.	9.730 grms.	49.83 grms.
" II,	84.03* "	424.03 "	9.77 "	11.497 "	58.19 "

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* To render the results better comparable the nitrogen of the asparagin and gelatin is, in all cases, multiplied by 6¼ and counted as albuminoids.

These results show plainly that asparagin, at least, is a nutrient and that when added to a fodder already containing albuminoids it may cause a gain of flesh.

It probably acts in the way already suggested, viz., by protecting a portion of the albumoids from oxydation.

That this is the case is indicated by the fact that in these experiments a gain of sulphur by the body was observed. All the albuminoids contain this element while asparagin is free from it, and we therefore must consider it highly probable that the flesh gained by the animals was formed from the albuminoids of the food.

The most important fact shown by the above results, however, is that the gain of flesh caused by the asparagin was very nearly as great as that produced by a quantity of albuminoids containing the same amount of nitrogen.

From this it would appear that, while a ration consisting of asparagin and non-nitrogenous nutrients only, cannot sustain life, the former substance is fully capable of taking the place of a considerable part of the albuminoids and is practically just as valuable as they, *so far as the formation of flesh is concerned*, for increasing the richness of a ration already containing a reasonable amount of albuminoids.

Other Amides.—Whether what Weiske has shown regarding asparagin is true of other amides as well, can of course be decided only by direct experiment; but in the mean time, while we must beware of drawing too general conclusions from a single experiment, it seems highly probable that those amides which other investigators have shown to be decomposed in the body may, like asparagin, contribute to its nourishment. These include several of the more commonly occurring bodies of this class, while only one (acetamide) has been tried with negative results.

But if what is true of asparagin applies to amides in general, then it follows that these bodies as they occur in feeding-stuffs, i. e., associated with comparatively large quantities of albuminoids, are just as valuable for the production of flesh as the latter, since, when fodders containing them are used, we have essentially the conditions of Weiske's experiments, viz: amides added to a fodder containing considerable true albuminoids, and should expect the same results.

None of the experiments yet made touch the very important question of the influence of amides on the production of fat, either as body-fat or milk-fat. It has been conclusively shown that the albuminoids serve as a source of fat in the body but it is difficult to see how fat could be formed from amides. On the other hand it is quite possible that they, like the carbhydrates, may protect the fat of the body or of the food from oxydation.

Conclusions.—We are now prepared to consider how far the results of feeding experiments already made, and the value of analyses of feeding-stuffs stand affected by the fact of the presence of amides in many of our common fodders.

Feeding experiments may be made, first, to ascertain the general laws of animal nutrition; or, second, to determine the amounts of the various nutrients demanded in the fodder of animals under various circumstances, i. e., to establish *feeding-standards.*

Regarding the first of these objects it is sufficient to say here that the general laws of nutrition, so far as they have yet been worked out experimentally, are in no essential respect invalidated by the facts which have been presented here.

As to the second object, the establishment of feeding-standards, it is to be remembered that these feeding-standards are not deduced from any theoretical considerations but are simply the combined results of more or less numerous carefully conducted feeding trials. In these experiments feeding-stuffs have been used which have subsequently been shown to contain amides and their results, when allowance is made for this fact, might be expressed somewhat as follows:

So much digestible albuminoids *and amides*, along with such and such amounts of digestible carbhydrates and fat, proved a suitable ration for the purpose intended.

Now in compounding a ration in accordance with a feeding-standard like the above the farmer would naturally use, to a considerable extent, feeding stuffs similar to those used in the original experiments, and in all probability the proportions of albuminoids and amides in the two rations would not vary very greatly.

Moreover, it would appear from our present knowledge that any difference which might exist would only affect the value of the ration as a fat producer, while as regards the formation of flesh the two rations would be on an equality.

If we add to this the fact that the feeding-standards themselves are but approximations, and are not to be blindly followed but intelligently modified to suit varying. circumstances, we shall see that, in spite of some ambiguity, a feeding-standard may yet be a valuable aid in applying the experience gained by other experimenters to our own particular case.

Still further, if we know, as we easily may, the proportion of albuminoids and of amide-like bodies in the feeding-stuffs which we use, we have, even with our present limited knowledge of the subject, the basis for forming a tolerably intelligent judgment as to whether our ration is deficient in true albuminoids or not.

It is, of course, desirable that feeding-standards should distinguish between albuminoids and amides, and doubtless this will be done to a large extent in future investigations. Meanwhile the considerations here presented seem to show that those which we possess at present are far from having lost their practical value when intelligently used. The study of the nutritive value of amides and other non-albuminoid nitrogenous constituents of feeding-stuffs is scarcely begun as yet and but few certain conclusions have been reached, but all the results hitherto brought to light warn us against hastily concluding that these substances are valueless or pronouncing the results of fodder analyses and feeding experiments to be, on this account, uncertain and misleading.

EXAMINATIONS OF SEEDS.

Eight samples of seed have been sent to the Station for examination during the year. One of these was Hungarian grass seed, sent Oct. 6, by J. M. Hubbard, Esq., of Middletown. In a letter of the same date he says: "The sample is from a lot sown the past season which failed to germinate. Its failure involved considerable loss and I desire to know from some good authority whether the fault was in the seed or in my management."

The seed contained only 2.7 per cent. of foreign matter, which was chiefly dust and chaff with a few seeds of other plants, and was practically "pure." But out of 400 seeds which were tested only one germinated. The seed which was worthless in October could scarcely have been otherwise in April.

Seven samples of onion seeds have been sent by Messrs. S. M. & D. Wells, of Wethersfield.

43	is Wethersfield	large	red.	Crop of	1870.
44	"	"	"	"	1876.
45	"	"	"	"	1877.
46	"	"	"	"	1878.
48	"	"	"	"	1879.
49	is Yellow Danvers.			"	1879.
50	is White Portugal.			"	1879.

The first four were sent and examined in April, the others late in the year, so that **46**, as well as those following, represents seeds less than one year old.

The results are as follows:

	1,000 Seeds Weighed. (Grams.)	Of 100 Seeds Sprouted. (Vitality.)	Time of Germination.	
			Half Sprouted.	All Sprouted.
43	3.60	0.	—	—
44	4.16	70.	11 days.	17 days.
45	3.44	62.5	9 "	18 "
46	3 74	92.5	6 "	11 "
48	3.91	92.5	5 "	9 "
49	3.49	85.8	4 "	9 "
50	3.72	75.8	4 "	9 "

With regard to the first four samples, Messrs. Wells write: "The samples were all grown by ourselves. It is claimed by many seedsmen that the crop of 1877 is better for planting this season than the crop of 1878. We know from our own observation and experience that 'old seed' is of no value if 'new seed' can be purchased for ten dollars per lb. The old seed has so little vitality that unless the season is exceptionally favorable it will not make a crop. If dealers in seeds would purchase new seeds and not mix in their old stock there would be no trouble with their guarantee."

The Station tests show that the newest seed (1878) is decidedly the best, judged both by the per cent. that sprouted and the promptness of germination. The sample of 1877 seemed to be inferior to that of 1876. The seed of 1870 was worthless.

With regard to the crop of 1879, Messrs. Wells say: "This season at about the time the seed was 'in the milk' we suffered from a severe storm of rain and wind, which beat the seed to the ground and it did not mature as well as it would have done had the weather been favorable. The field on which the White Portugal was sown suffered more severely than the others."

The tests show that while the Wethersfield large red onion is of as good quality as the year before, the Yellow Danvers and especially the White Portugal do not have as high germinating power. Possibly this is due to damage received in the stormy weather alluded to.

VITALITY OF SEEDS.

In his letter of October 9, giving an account of a sediment from a cove on the Connecticut River, Mr. G. I. Stevens of Essex, writes: "I put some of the mud on a worn out pasture and it came up thick with white clover. Where did the seed come from? This mud is under water the year round."

In answer was written: "Why the mud has brought in white clover I cannot say with certainty, but most probably clover seed did not come in the mud. It often happens that when white clover appears like a new growth as a result of some application such as gypsum, ashes, or lime, that the plant already is rooted in the soil but has had only a suppressed and unnoticed existence, until some favorable condition supervenes, which enables it to get the upper hand of the other vegetation and make itself manifest."

Since the above was written, facts have recurred to my recollection which show that the seeds of white clover may have come from the mud.

The investigations of Nobbe (*Handbuch der Samenkunde*, p. 112, and *Landw. Versuchs-Stationen*, XX, 71) have demonstrated that among the seeds of clover and related plants *some, usually a small proportion, are able to resist the action of water* for several months or even years, remaining hard and unswollen and retaining their vitality.

In one experiment 1000 seeds of red clover were soaked in distilled water and then placed in a sprouting apparatus, where they were kept moist and warm for 156 days. In the course of one day 919 of the seeds sprouted, while of the remaining 81, 51 became softened at various times in course of the experiment, and 30 remained entirely unaffected.

In another experiment, out of 64 seeds of white clover remaining hard after 10 days soaking, 16 (= 25 per cent.) softened in course of 282 days more and 8 (= 12½ per cent.) sprouted. Of these 2 sprouted on the 75th day, 2 on the 209th day, and 1 on the 247th day after their first immersion in water. In still another experiment with seeds of the yellow locust (*Robinia pseudacacia*) which was continued nearly two years and nine months the following results were obtained:

	Sprouted.	Rotted.	Remained hard.
Sample 1,	37.5 per cent.	38 per cent.	28 per cent.
" 2,	50 "	35 "	15 ",

Of these 71 had sprouted on the 10th day after immersion, 27 more on the 29th day, 20 more on the 152d day, 8 more on the 260th day, 10 more on the 341st day, 5 more on the 462d day, 3 more on the 605th day, 1 more on the 769th day, 3 more on the 853d day, 2 more on the 1012th day.

Prof. Brewer states that according to Pouchet, some seeds of the *Medicago Americana* resisted the action of boiling water for four hours, and afterwards when planted in a suitable soil grew in from 10 to 20 days.

Nobbe has shown that the resistance of seed to the action of water which was observed in his experiments was located in the outer membrane of the seeds, which is *occasionally almost impervious to that liquid.*

ON THE DETERMINATION OF NITROGEN.

In the Station Report for 1878* the comparative merits of the two methods employed by chemists for the quantitative determination of nitrogen in agricultural products, were discussed and full details were given of the precautions which our experience has led us to adopt in applying the soda-lime process. The notion that the so-called "absolute method" is more exact than the soda-lime process, and that the albuminoid bodies can only be analyzed by the former method, made it necessary to submit both processes to critical experimental study, and our conclusion was that the two methods, when properly worked, give results that agree within 0.05 to 0.15 per cent. We found, moreover, confirmation of the long recognized fact that the errors of the soda-lime process naturally tend to give a deficiency, and those of the absolute method an excess of nitrogen. We gave but a brief outline of our mode of working the absolute method. The circumstance that other chemists are still undecided as to the merits of the two processes, and that the absolute method must be frequently employed in the analyses of fertilizers containing both nitrates and organic nitrogen, decides us to give a detailed account of the procedure which we have adopted and which gives us so satisfactory results.

REAGENTS.

Cupric oxide.—"Copper scale," which may contain cuprous oxide, coal dust, oil, etc., is mixed in an iron pot with 10 per cent. of potassium chlorate and enough water to make a thin paste. The mass is heated and stirred till dry, the heat is then raised to the point of ignition, and continued until the mass does not glow nor sparkle when stirred.

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* Also American Chemical Journal, Vol. 1, p. 74.

The potassium chloride is washed out by decantation and the cupric oxide is dried and moderately ignited.

Metallic copper.—Granular copper oxide, or fine copper gauze is suitable for its preparation. The granular copper is most convenient; copper gauze must be made into rolls adapted to the combustion tube. The copper is reduced and cooled as usual in a stream of hydrogen.

Potassium chlorate.—Commercial potassium chlorate is fused in porcelain and pulverized.

Sodium bicarbonate must contain no organic matter.

Solution of Caustic Potash.—Dissolve commercial "stick potash" in less than its weight of water, making a solution so concentrated that, on cooling, it deposits crystals of potassium hydrate.

The same clear solution may be used for a number of combustions or until the absorption of carbonic acid gas is not quite prompt.

APPARATUS.

The Combustion tube should be of the best hard Bohemian glass, about 2 feet 4 inches long. The rear end is bent and sealed as in Fig. 3.

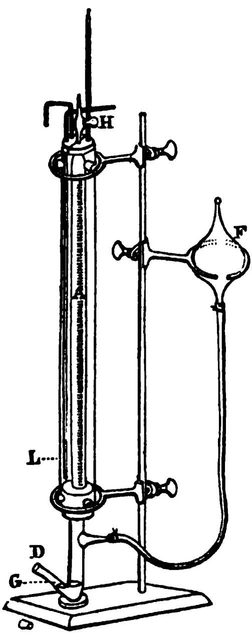
It is best to protect the horizontal part with thin copper foil. The tube is connected with the pump by a close fitting rubber cork, smeared with glycerine.

Azotometer.—This is a modification of the apparatus invented and described by Schiff, *Fres. Zeitschrift*, Bd. 7, p. 430.

It is represented in Fig. 1.

The gas is measured in an accurately calibrated cylinder (burette), A, of 120 c. c. capacity, graduated to fifths of cubic centimeters, and closed at the upper end by a glass stopcock. The lower end is connected by means of a perforated rubber stopper about 1¾ inches long and 1¼ inches diameter, with another tube having two arms, one, D, to receive the delivery tube from the pump, the other connected by a rubber tube with a bulb of 200 c. c. capacity, F, through which potash solution is supplied. The graduated tube is enclosed in a water-jacket with an external diameter of about 1¾ inches. Its lower end is closed by the caoutchouc stopper that connects the two parts of the azotometer described above. The upper end of the jacket is closed by a thin rubber disc, slit radially and having four perforations: one in the center, through which the neck of the graduated tube passes, and three others near the circumference.

Fig. 1.



Through one of the latter, a glass tube, L, bent as in the figure, reaches to the bottom of the jacket, another short tube just passes through the disc, and the third hole is for supporting a thermometer. The azotometer is held upright and firm on a stand by rings fitting around the jacket and by cork wedges.

The bulb for potash solution rests in a slotted, sliding ring.

The air pump used, is the Sprengel mercury pump, modified merely so as to be easily constructed and durable. Its essential parts are sketched in Fig. 2. Some of them are exaggerated in order to show their construction more plainly. Through a rubber stopper wired into the nozzle of the mercury reservoir, A, passes a glass tube, B, 4 inches long, this connects by a caoutchouc tube with the straight tube, D, 3 feet long. The rubber tube E, 6 inches long, connects D with a straight glass tube F, of about the same length as D.

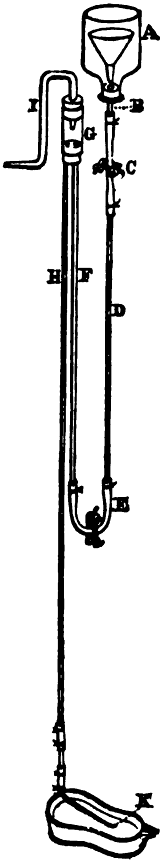
G is a piece of combustion tube 1½ inches long, closed below by a doubly perforated soft rubber stopper admitting the tubes F and H, and above by a singly perforated rubber stopper into which a tube, I, is fitted. The tube H has a length of 45 inches. At the bottom it is connected by rubber with a straight tube of 3 inches, and this again with a tube, K, of 7 inches. The tubes H K should have an internal diameter of 1½ millimeters, F may be 2 millimeters, and D still larger.

We have used for H and F slender Bohemian glass tubes of 4 millimeters exterior diameter. Their elasticity compensates for their slenderness. If heavy barometer tubes be used the stoppers and G must be of correspondingly larger dimensions.

The joints at G must be made with the greatest care.

It is best to insert the lower stopper for half its length into G, having the dimensions of the parts so related that it requires considerable effort to force the slightly greased tubes F and H to their places just through the stopper. The tube I must be of *stout glass*—a decimeter in diameter. It is drawn out at either end to a long taper, and bent as in the figure, in order to bring its free extremity to the level of the combustion furnace. The hole in the upper rubber stopper has a diameter of 5mm., just sufficient to admit the narrowed end of the tube, which, after greasing or moistening with glycerine, is "screwed down" into the stopper.

FIG. 2.



These three joints are the only ones belonging to the pump which have to resist diminished pressure, and require extreme care in making.

If not entirely secure they are to be trapped with glycerine. For this purpose it is needful to pass F and H through a stopper of half an inch greater diameter than G and correspondingly perforated, before entering the latter. Then, previous to inserting I, a tube 4 inches long is slipped over G upon this wider stopper. When I has been inserted and the tubes have been secured to their support, the space between G and the outer tube is filled with the most concentrated glycerine which is, prevented from absorbing moisture by corking above.

The two rubber tubes are both provided with stout screw clamps, to admit of exactly regulating the flow of mercury. The tubes D, F, H, and I are secured to a vertical plank framed below into a heavy horizontal wooden foot on which rests the mercury trough, and having above a horizontal shelf through an aperture of which passes the neck of A.

The tubes D, F, H, and I are secured to the plank at several points by wooden or cork clamps, clasping the tubes and fastened by screws or wires.

These fastenings are made elastic by the intervention of a thick rubber tube between the glass and wood. The connections C and E should be made of stout vulcanized rubber, those at the base of H K of fine black rubber.

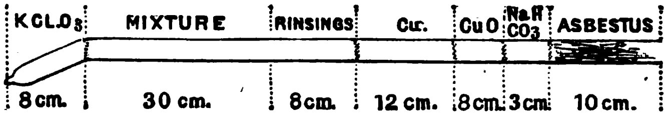
The latter should be soaked in melted tallow previous to use all excess being carefully removed from the interior. The joints should be wound with waxed silk.

A glass funnel is placed within A to prevent spattering of the mercury when it is filled.

OPERATION.

From 3 to 4 grams of potassium chlorate, according to the amount of carbon to be burned, are put into the tail of the combustion tube, Fig. 3, followed by an asbestos plug just at the bend.

Fig. 3.



The substance to be analyzed (0.6–0.8 grams) is well mixed in a mortar with enough cupric oxide that has been *freshly ignited* and allowed to cool, to make a layer 11 or 12 inches long in the tube. The mixture is introduced through a funnel and rinsed with enough cupric oxide to make a layer of 3 inches, a second asbestos plug, and upon it a layer of reduced copper of 4 or 5 inches long are put in, then a third asbestos plug, then 2 inches of cupric oxide, a fourth asbestos plug, then .8 to 1. grams of sodium bicarbonate. The remaining space in the tube is loosely filled with asbestos, to absorb the water which is formed during combustion, and prevent it from flowing back upon the heated glass. The anterior part of the tube containing the cupric oxide and reduced copper is wound with copper foil, leaving, however, a little of the copper (Cu. in fig. 3) visible at its rear. The combustion tube is placed in the furnace at the bend of the tube I, and connected with the latter by a close-fitting rubber stopper smeared with glycerine.

Care must be taken to make the joint perfectly tight. The combustion tube has its conical rubber stopper partly inserted, and is then forced and rotated upon the tapering and stout end of the tube I, the latter being supported by one hand applied at the lower bend.

PREPARATION OF THE AZOTOMETER.

Fill the bottom of the azotometer to about the level indicated by the dotted line G, with mercury. Close the arm D securely with a rubber stopper. Grease the stop-cock H and insert the plug, leaving the cock open.

Pour potash solution into F till A is nearly full, and there is still some solution in the bulb F. Raise the bulb cautiously with one hand, holding the stop-cock H in the other hand. When the solution in A has risen *very nearly* to the glass cock, close the latter, avoiding contact of the alkali with the ground glass bearings. Replace the bulb in the ring and lower it as far as may be. If the level of the solution in the azotometer does not fall in 15 or 20 minutes, it is tight. Place the delivery tube of the pump K in a mercury trough.

Supply the vessel A with at least 500 c. c. of mercury. Cautiously open the clamps C and E. If the mercury does not start at once pinch the rubber at E repeatedly. The mercury should flow nearly as fast as it can be discharged at K, without filling the cylinder G. Five to ten minutes working of the pump will generally suffice to make a complete exhaustion of the combustion tube. If most of the mercury runs out before exhaustion is complete, close the clamp C, return the mercury to A, and repeat the operation. When there is a complete exhaustion, the mercury falls with a rattling or clicking sound. After it has been distinctly heard for half a minute, close the clamp C. If the mercury column in H remains stationary for some minutes, the connections are proved to be tight.

ADJUSTING THE AZOTOMETER.

Remove the mercury trough, placing K in a capsule.

Heat the part of the tube containing sodium bicarbonate. Water vapor and carbon dioxide are evolved, which fill the vacuum in H and expel the mercury. While this is being done place the azotometer near by, remove the bulb F from the ring and support it in a box near the level of D, so that the stopper may be removed from D without greatly changing the level of the mercury G, and so that the azotometer can be moved freely without disturbing it. When the cork in D has been removed fill D half full or more with water.

As soon as the mercury has fully escaped from K insert the latter in D. Let a few bubbles escape through the water and then pass the tube K down so that the escaping gas enters the azotometer. It will much facilitate the delivery of gas if the extremity of the tube K just touches the inside of the azotometer tube, and is kept, as near as possible, to the surface of the mercury.

The carbon dioxide is absorbed in passing through the caustic potash solution. In spite of all precautions very minute bubbles of permanent gas will occasionally ascend, but, as will be seen on observing the amount of potash solution thus displaced, the error thereby occasioned is extremely small.

THE COMBUSTION.

First heat the anterior cupric oxide to full redness, and after wards the copper. The fine gauze or pulverulent copper very completely reduces any oxides of nitrogen which might be produced in the combustion, and also retains any excess of oxygen which is evolved at the close of the process.

The anterior cupric oxide burns the traces of hydrogen which may be held by the reduced copper, even when the tube is exhausted, and also destroys the carbon monoxide which is usually formed when steam and carbon dioxide pass together over reduced copper, if iron or carbon be present. Go on with the combustion as usual bringing the heat up to a fair redness. The flow of gas may be made quite rapid, say one bubble a second, or a little faster.

When the horizontal part of the tube has all been heated, and the evolution of gas has nearly ceased, heat the potassium chlorate so that it boils vigorously from evolution of oxygen. The reoxidization of the reduced copper oxide and of any unburned carbon proceeds rapidly.

When the oxygen, whose flow admits of easy regulation, begins to attack the anterior layer of reduced copper, stop its evolution and lower the flames all along the tube, keeping the reduced copper still faint red.

After a few minutes start the pump, slowly at first, having some vessel under the tube D of the azotometer to receive the mercury. A few minutes pumping suffices to clear the tube. Remove the azotometer, close the tube D with its rubber stopper, then raise the bulb into its ring to such a height that the potash solution in it shall be at about the same level as that in the graduated tube. Connect L at its upper end with a water supply, insert a thermometer in the top of the water jacket and let the water run until the temperature and the volume of gas are constant.

Read off the volume of gas and the temperature, after having accurately adjusted the level of the solution in the bulb to that in the azotometer.

Read the barometer and make the calculations in the usual way. When 50 per cent. potash solution is used, no correction need be made for tension of aqueous vapor, as Schiff has shown.

The calculation is somewhat shortened by the use of the table in Jour. of Chem. Soc., Vol. XVIII, (1865), p. 212.

Very fair results are got by employing, with suitable precaution, a stream of carbon dioxide to displace the air of the combustion tube, but the process is very tedious, the sources of error are more numerous, and the results are apt to be higher and not so accordant as when the mercury pump is used to evacuate the tube.

The pump above described has been in use for eighteen months without any repairs, and by its help two or even three analyses may be performed in a day.

The paper in Station Report for 1878, already referred to, gives results of analyses of a variety of substances by the method above described.

Some additional comparative analyses recently made by Dr. Jenkins, on carefully prepared, but not dry, albuminoids have given the subjoined results for nitrogen:

	By Soda Lime.	By Absolute Method.	Average Differences.
Albuminoid of Pea Nuts, - -	15.95	15.92	——
Legumin of Peas, - - -	15.32–15.27	15.41	0.11
Conglution of Almonds, .. -	16.32–16.87	16.59	0.25

ANALYSES OF NORTH AMERICAN FODDER AND FEEDING STUFFS.

See page 9.

COMPILED BY DR. E. H. JENKINS.

In the following list are given references to such published analyses as have not been included in these tables. Some are partial analyses, several proximate elements being left undetermined, others were made on specially selected samples, e. g., on particularly large or small seed, and others were made by methods which prevent comparison with other analyses.

Apple. Trans. N. Y. Ag'l. Soc., 1849, p. 737.
Artichoke. " " " " 1850, p. 339.
Beet. " " " " 1852, p. 323.
Beans. U. S. Dept. Ag., 1878, p. 124.
Buckwheat. U. S. Pat. Off. Rep., 1849, p. 470.
Carrot. Trans. N. Y. Ag'l. Soc., 1852, p. 323.
Celery. " " " 1852, p 323.
Chicory. Ohio Ag'l. Rep., 1862, p. 254.
Cucumber. Trans. N. Y. Ag'l. Soc., 1852, p. 323.
Endive. " " " 1852, p. 323.
Maize. Trans. N. Y. Ag'l. Soc., 1848, p. 678.
U. S. Pat. Off. Rep., 1849, p. 470.
" " " 1857, p. 160.
" " " 1873, p. 180.
" " " 1875, p. 144.
Muskmelon. Trans. N. Y. Ag. Soc., 1852, p. 323.
Parsnip. " " " 1850, p. 339.
Peanut. U. S. Dept. Ag., 1870, p. 92.
Peas. " " " 1878, p. 124.
Rhubarb. Trans. N. Y. Ag. Soc., 1849, p. 737.
"Tuckahoe." U. S. Dept. Ag., 1871, p. 98.
Vegetable Oyster (salsify). Trans. N. Y. Ag. Soc., 1852, p. 323.
Watermelon. Trans. N. Y. Ag. Soc., 1852, p. 323.
Wheat. Ohio Ag. Rep., 1857, p. 727.
U. S. Pat. Off. Rep., 1840, p. 64.
Yam (Chinese). U. S. Pat. Off. Rep., 1857, p. 165.

In a considerable number of cases analysts have determined sugar, gum, dextrin, wax. &c.

Such analyses have been recalculated, the wax reckoned as fat and the other ingredients collectively as N. fr. (nitrogen-free) Extract. These analyses are indicated as follows:—

† That sugar, gum, albuminoids soluble in alcohol—sometimes called "Zein"—and albuminoids insoluble in alcohol were determined.

* That wax, sugar, gum and dextrin, "amylaceous cellulose" and "alkali extract" were determined.

‡ That sugar and gum were determined.

Albuminoids in all cases signify the percentage of nitrogen multiplied by 6.25.

I. Grain and Other Seeds.

No.	Variety.	Reference.	Anal
	Maize (*Flint Corn*).		
1	Norfolk White, large, 16 rowed, N. C.,..	Rep. Ct. Ag'l. Ex St. '77, p. 57,	S. W. Jo
2	Vermont White Cap, 1877, Ct., ...	" " " " "	"
3	Rowley, 1877, Ct.,..............	" " " " "	"
4	Western Yellow, ground exclusively for feed. Raised at the West,...........	Rep. Mid. Ag. Ex. St. '77–8, p. 29,	W. O. At
5	Southern White,...	" " " "	"
6	Yellow or Canada, 8 rowed, Conn., 5 bushels shelled corn to the acre,......	" " " "	"
7	Early Dutton, 12 rowed, kernels rather small, ...	Am. Jour. Sci. & Arts, '69, p. 352,	"
8	Common Yellow or Canada, 8 rowed, kernels good size.	" " " "	"
9	King Philip or Rhode Island. Brown red, 8 rowed, kernels large,.......... ..	" " " "	"
10	Smut nose. Mich , ...	Rep. Mich. Bd. Ag. '78, p. 409,	R. C. Kedz
11	" " "	" " " "	" "
12	8 Rowed Flint. Mich.,...............	" " " "	" "
13	Sanford. Mich ,.................	" " " "	" "
14	Compton's Early. Penn., ...	Rep. U. S. Dept. Ag., '78, p. 149,	Peter Collie
15	Adams. N. Hampshire,........... ...	" " " "	" "
16	Canada. "	" " " "	" "
17	Vermont. Vermont,.................	" " " "	" "
18	Small 12 rowed. N. Hampshire,.......	" " " "	" "
19	State Fair Premium, "	" " " "	" "
20	Large Premium, "	" " " "	" "
21	Board of Agriculture, "	" " " "	" "
22	King Philip, "	" " " "	" "
23	Pop Corn, white, ...	" " " "	" "
24	Improved Prolific, Tennessee,..........	" " " 148,	" "
25	White Mexican, Mexico, ...	" " " "	" "
26	Oregon White, Oregon, ...	" " " "	" "
27	Small, 8 rowed, New Hampshire,.......	" " " "	" "
28	Miscegenation, (white and blue), New Hampshire,.......................	" " " "	" "
29	Pitch Knot, New Hampshire, ...	" " " "	" "
30	Tom Thumb, Yellow, New Hampshire,..	" " " "	" "
31	Old Fashioned Yellow, 1878. Conn., ...	Rep. Ct. Ag. Ex. St., '79, p. 88,	S. W. Johns
	Average Composition, (31 Analyses),		
	Maximum, ...		
	Minimum,......................		
	Maize (*Dent Corn*).		
32	Ohio Dent, 1877, Conn................	Rep. Ct. Ag. Ex. St. '77, p. 57,	S. W. Johns
33	Yellow Dent, 1877, Mich.,.......	Rep. Mich. Bd of Ag., '78, p. 408,	R. C Kedzie,
34	" " " "	" " " "	" "
35	White " " "	" " " "	" "
36	Hackberry Dent, 1877, Mich., ...	" " " "	" "
37	Strawberry Roan, " "	" " " 409,	" "
38	White Oil, Indiana, ...	" " " "	" "
39	Pony Dent, Mich.,...................	" " " "	" "
40	" "	" " " "	" "

I. GRAIN AND OTHER SEEDS.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-free. Ash.	Albuminoids	Fiber.	N. fr. Extract.	Fat.
1	11.17	1.81	10.88	1.90	70.04	4.70	1.48	12.25	2.14	78.84	5.29
2	10.86	1.53	11.06	1.04	71.22	4.29	1.72	12.41	1.17	79.89	4.81
3	11.00	1.61	11.63	.78	70.15	4.83	1.81	13.06	.88	78.83	5.42
4	13.93	1.25	8.82	1.59	70.48	3.92	1.45	10.25	1.85	81.89	4.56
5	13.82	1.32	8.80	0.88	71.07	4.02	1.53	10.81	1.02	82.47	4.67
6	15.10	1.36	10.01	1.24	66.99	5.31	1.60	11.56	1.69	78.90	6.25
‡7	8.08	1.52	9.62	2.52	72.62	5.64	1.66	10.46	2.74	78.98	6.16
‡8	10.52	1.31	9.72	2.40	71.63	4.42	1.46	10.86	2.68	80.06	4.94
‡9	9.79	1.60	11.87	2.21	70.08	4.45	1.77	13.16	2.45	77.69	4.93
‡10	12.90	1.54	11.81	2.00	66.81	4.94	1.76	13.55	2.29	76.63	5.67
‡11	13.26	1.49	11.51	2.49	66.11	5.14	1.72	13.27	2.87	76.21	5.93
‡12	13.45	1.43	12.00	2.26	66.03	4.83	1.65	13.86	2.61	76.30	5.58
‡13	13.37	1.37	10.69	2.10	67.41	5.06	1.58	12.34	2.42	77.82	5.84
†14	6.59	1.64	9.90	2.09	74.48	5.30	1.76	10.59	2.24	79.74	5.67
†15	8.61	1.57	10.50	1.19	73.30	4.83	1.72	11.48	1.30	80.22	5.28
†16	8.27	1.72	11.36	1.26	71.79	5.60	1.87	12.36	1.37	78.29	6.11
†17	8.64	1.45	10.14	1.38	72.76	5.63	1.59	11.10	1.51	79.63	6.17
†18	11.48	1.34	10.50	1.09	69.56	6.03	1.51	11.87	1.23	78.58	6.81
†19	10.19	1.78	10.82	1.06	70.86	5.29	1.98	12.05	1.18	78.90	5.89
†20	10.00	1.46	11.36	1.09	70.57	5.52	1.62	12.63	1.21	78.40	6.14
†21	11.09	1.31	11.56	.82	70.55	4.68	1.47	12.99	.90	79.38	5.26
†22	10.23	1.84	12.08	1.01	67.79	7.05	2.04	13.47	1.13	75.50	7.86
†23	8.61	1.63	13.13	2.32	68.68	5.63	1.78	14.37	2.54	75.15	6.16
†24	7.58	1.23	9.29	2.65	74.16	5.09	1.33	10.05	2.87	80.24	5.51
†25	8.65	1.87	10.15	1.64	72.79	4.90	2.04	11.11	1.79	79.70	5.36
†26	9.25	1.46	7.88	1.26	73.07	7.08	1.61	8.68	1.39	89.52	7.80
†27	11.05	1.57	13.65	1.30	67.63	4.80	1.76	15.35	1.46	76.03	5.40
†28	9.92	1.63	11.72	1.05	70.35	5.33	1.81	13.01	1.17	78.09	5.92
†29	11.24	1.52	11.20	1.04	69.74	5.26	1.71	12.62	1.17	78.58	5.92
†30	9.05	1.60	12.60	1.33	69.53	5.89	1.76	13.85	1.46	76.46	6.47
31	10.58	1.48	9.81	1.39	72.11	4.63	1.60	10.99	1.55	80.63	5.28
	10.58	1.50	10.70	1.56	70.19	5.16	1.67	12.13	1.71	78.72	5.77
	15.10	1.87	13.65	2.67	74.48	7.08					
	6.59	1.25	7.88	.78	66.11	3.92					
32	10.78	1.37	10.06	1.35	71.30	5.14	1.54	11.27	1.51	79.92	5.76
‡33	12.74	1.41	11.75	2.49	66.98	4.63	1.62	13.47	2.85	76.75	5.31
‡34	11.66	1.51	11.48	2.48	67.80	5.07	1.71	12.99	2.81	76.75	5.74
‡35	13.73	1.60	11.52	2.26	66.26	4.63	1.85	13.35	2.62	76.81	5.37
‡36	12.47	1.47	9.88	2.30	69.11	4.77	1.68	11.29	2.74	78.84	5.45
‡37	14.05	1.39	10.31	2.03	67.63	4.59	1.62	12.00	2.36	78.68	5.34
‡38	11.29	1.28	10.50	1.90	70.16	4.87	1.44	11.83	2.14	79.10	5.49
‡39	13.42	1.40	11.25	2.16	66.94	4.83	1.62	12.99	2.49	77.32	5.58
‡40	13.29	1.31	10.63	2.21	67.53	5.03	1.51	12.26	2.55	77.88	5.80

I. Grain and Other Seeds.

No.	Reference and Remarks.		Name of Analyst.
	Maize (*Dent Corn*).—Continued.		
41	White Dent, N Carolina,...............	Rep. U.S. Dept. Ag.,'78, p. 148,	P. Collier,
42	Mexican White Dent, Mexico, ...	" " " "	"
43	White Prolific, Penn., ...	" " " "	"
44	Coe's Prolific, 1878, Conn.,.........	Rep. Ct. Ag. Ex. St., '79, p. 88,	S. W. Johnson,
45	Benton " "	" " " "	" "
46	Scioto, 1878, Conn., ...	Rep. Ct. Ag. Ex. St., '79, p. 88,	" "
47	White Ohio, 1878, Conn.,..............	" " " "	" "
48	Wisconsin, " "	" " " "	" "
49	White Prolific, " "	" " " "	" "
50	Extra Early Adams, 1878, Conn.,.......	" " " "	" "
	Average, (19 analyses), ...		
	Maximum, ...		
	Minimum.......................		
	Maize (*Sweet Corn*).		
51	Immature Sweet, Conn., Harvested Aug. 9, 1877,............................	Rep. Ct. Ag. Ex. St.,'78, p. 67,	S. W. Johnson,
52	Immature Sweet, Harvested Aug. 25, '77.	" " "	" "
53	Full grown Sweet, Harvested Sept. 25, '77,	" " "	" "
54	Stowell's Evergreen Sweet, 12 and 16 rowed. Ears short and thick. Conn.,..	Am. Jour. Sci. & Arts,'69, p. 352,	W. O. Atwater,
55	Stowell's Evergreen, N. England,.......	Rep. U.S. Dept. Ag.,'78, p. 148,	P. Collier,
56	Egyptian, Maryland.	" " "	"
57	Red River, Minnesota,................	" " "	"
58	Golden Sugar, Mass., ...	" " "	"
59	Marblehead, Mammoth, Mass.,..........	" " "	"
60	Prolific..............................	" " "	"
61	Proctors, Mass.,......................	" " "	"
62	Mexican Blue Mexico, ...	" " "	"
63	Mammoth Sweet, 1878, Conn.,..........	Rep. Ct. Ag. Ex. St., '79, p. 88,	S. W. Johnson,
	Average, (11 analyses),*		
	Maximum, ...		
	Minimum,......................		
	Maize (*Unclassified*).		
64	Tuscarora, 1877, Conn.,................	Rep. Ct. Ag'l Ex. St '77, p. 57,	S. W. Johnson,
65	Tuscarora, 1877, Mich., ...	Rep. Mich. Bd. Ag. '78, p. 409,	R. C. Kedzie,
	Average of all varieties, (63 analyses,)		
	Maximum, ...		
	Minimum, ...		
	Winter Wheat.		
†1	Michigan White Winter. Milling extra. Detroit inspection. Cleaned for grinding,	Rep. Mid. Ag. Ex. St.,'77-8, p. 25,	W. O. Atwater,
2	Missouri Red Fall. St. Louis inspection. Cleaned for grinding,................	" " " "	" "
3	Diehl, Mich.,.	Rep. Mich., Bd. Ag.'77, p. 350,	R. C. Kedzie,
4	" "	" " " 351,	" "
5	" "	" " " 350,	" "

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* 51 and 52 excluded

† These figures differ from those given in *loc. cit.* which have been corrected by the analyst.

I. GRAIN AND OTHER SEEDS.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-free. Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
†41	6.74	1 48	11.08	1 53	74.09	5.18	1.58	11.82	1.63	79.47	5.55
†42	11.14	1.45	10.67	1.59	68.87	6.28	1.64	11.99	1.79	77.51	7.07
†43	8.96	1 43	8.05	1.25	74.49	5.82	1.57	8.84	1.37	81.82	6.40
44	9.55	1.45	10.18	2.19	72.70	3 98	1.60	11.21	2.42	80.36	4.41
45	10.70	1.57	9.97	1.36	71.40	5.00	1.76	11.18	1.52	79.94	5.60
46	10.43	1.53	9.25	1.80	72.98	4.01	1.71	10.31	2.01	81.49	4.48
47	9.70	1.79	11.28	1.73	71.30	4.20	1.88	12 50	1.92	78.95	4.65
48	9.72	1.56	11.60	2.06	70.17	4.89	1.73	12.85	2.28	77.72	5.42
49	10.14	1.67	9.19	1.34	73.38	4.28	1.86	10.23	1.49	81.66	4.76
50	10.94	1.75	10.81	1.48	70.21	4.81	1.97	12.14	1.66	78.83	5.40
	11.18	1.48	10.49	1.86	70.20	4.84	1.67	11.81	2.10	78.96	5.46
	14.05	1.79	11 75	2.49	74.49	6 28					
	6.74	1.28	8.05	1.25	66.26	3.98					
(51)	10.12	2.19	14.50	2.57	62.70	7.92	2.44	16.14	2.86	69.75	8.81
(52)	10.09	2.08	15.31	2.52	61.78	8.22	2.31	17.02	2 80	68.73	9.14
53	9.45	2.06	14.38	1.93	63.05	9.13	2 27	15.88	2.13	69.64	10.08
‡54	10.86	1.89	11.10	2.63	65.86	7.66	2.12	12.45	2.95	73.89	8.59
†55	5.98	1.92	11.91	2.66	69 53	8.00	2.04	12.67	2 83	73.95	8.51
†56	7.54	1.92	11.55	2.02	69.17	7.80	2.07	12.58	2.19	74.78	8.53
†57	9.13	1.89	11,73	1.46	66.48	9.31	2.07	12 92	1.60	73.17	10.24
†58	6.27	1.93	14.35	1.58	66.70	9 17	2.06	15.31	1.69	71.16	9.78
†59	6.47	1.92	12.78	1.88	67.95	9.00	2.06	13.67	2.01	72 64	9.62
†60	10.38	1.87	10.33	2 04	67.73	7.65	2.07	11.49	2.26	75.68	8.50
†61	10.13	1.92	12.08	1.75	66.17	7.95	2.14	13.41	1.95	73,63	8.84
†62	8.97	1.42	10.21	1.80	72.35	5 25	1.56	11.22	1.98	79.47	5.77
. 63	9.48	1.93	12.32	2.75	66 09	7.48	2.13	13.61	3.04	72.97	8.26
	8 59	1.88	12.08	2 04	67.37	8.04	2.06	13.22	2.24	73.62	8.88
	10.86	2.06	14.38	2.75	72 35	9 31					
	5.98	1.42	10.21	1.46	63.05	5.25					
64	11.25	1.47	11.44	1.28	68.82	5.74	1.66	12.89	1.44	77.54	6.47
‡65	14.06	1.52	10.86	1.80	65.97	5.77	1.77	12.64	2.09	76.78	6.72
	10.47	1.56	10.96	1.78	69.69	5.59	1.74	12.22	2.00	77.80	6.24
	15.10	2.06	14.38	2.75	74.49	9.31					
	5.98	1.28	7.88	.78	63.05	3.92					
*1	12.75	1.56	11.64	1.83	70.96	1.26	1.79	13.34	2 10	81.33	1.44
2	13.52	1.55	11.79	1.72	69.95	1.47	1.79	13.63	1.99	80.89	1.70
3	9.64	1.72	12.38	.	76.26	..	1.90	13.69	..	84.41	..
4	12.18	1.82	13.78	..	72.22	..	2.07	15.68	..	82.30	..
5	12.68	1.77	11.81	..	73 74	..	2.08	13.54	..	84.43	..

I. GRAIN AND OTHER SEEDS.

No.	Variety.	Reference.	Analyst.
6	Diehl, Mich.,	Rep. Mich. Bd. Ag. '77, p. 350,	R. C. Kedzie,
7	Soules “	“ “ “ “	“ “
8	Soules, British Columbia,	“ “ “ “	“ “
9	“ “ “	“ “ “ “	“ “
10	“ “ “	“ “ “ “	“ “
11	Lincoln, Mich.,	“ “ “ “	“ “
12	Lincoln, “	“ “ “ “	“ “
13	Fultz, “	“ “ “ “	“ “
14	“ “	“ “ “ “	“ “
15	Treadwell “	“ “ “ “	“ “
16	“ “	“ “ “ “	“ “
17	“ “	“ “ “ “	“ “
18	Buckeye or White Wabash,	“ “ “ “	“ “
19	Tappahannock, Mich.,	“ “ “ “	“ “
20	Lancaster, “	“ “ “ “	“ “
21	Asiatic, “	“ “ “ “	“ “
22	Gold Medal, “	“ “ “ “	“ “
23	“ “	“ “ “ “	“ “
24	Egyptian Red, “	“ “ “ “	“ “
25	Clawson, “	“ “ “ “	“ “
26	“ “	“ “ “ “	“ “
27	“ “	“ “ “ “	“ “
28	“ “	“ “ “ “	“ “
29	“ “	“ “ “ “	“ “
30	“ “	“ “ “ “	“ “
31	“ “	“ “ “ “	“ “
32	“ “	“ “ “ “	“ “
33	“ “	“ “ “ “	“ “
34	“ “	“ “ “ “	“ “
35	“ Oregon,	“ “ “ 351,	“ “
36	Weeks, Mich.,	“ “ “ 350,	“ “
37	Powers, “	“ “ “ “	“ “
38	Armstrong, Mich.,	“ “ “ “	“ “
39	Tuscan, “	“ “ “ “	“ “
40	Post, “	“ “ “ “	“ “
41	Sonora Club, Oregon,	“ “ “ 351,	“ “
42	Yellow, Missouri,	Rep. U.S. Dept Ag.,'78, p. 147,	P. Collier,
43	Swamp, Ohio,	“ “ “ “	“
44	Victor, Canada,	“ “ “ “	“
45	Silver Chaff, Canada,	“ “ “ “	“
46	Foizy, Oregon,	“ “ “ “	“
47	Brazilian, “	“ “ “ “	“
48	Polish, Md.,	“ “ “ “	“
49	White, Oregon,	“ “ “ “	“
	Average, (49 analyses),		
	Maximum,		
	Minnimum,		
	Spring Wheat.		
50	Improved Fife, Canada,	Rep. U. S. Dept. Ag. '78, p. 48,	P. Collier,
51	Champlain, N. Y.,	“ “ “ “	“
52	Defiance, N. Y.,	“ “ “ “	“

I. GRAIN AND OTHER SEEDS.

No.	Water	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-free. Ash.	Water-free. Albuminoids.	Water-free. Fiber.	Water-free. N. fr. Extract.	Water-free. Fat
6	10.25	1.50	11.88	..	76.37	..	1.67	13.24	..	85.09	..
7	11.02	1.73	11.81	..	75.44	..	1.94	12.81	..	84.75	..
8	8.51	1.63	12.25	..	77.61	..	1 78	13.39	..	84.84	..
9	11.22	2.09	11.88	..	74.81	..	2.35	13.34	..	84.29	..
10	10.07	1.89	13.45	..	74.59	..	2.10	14.96	..	82.94	..
11	13.38	1.56	11.90	..	73.16	..	1.80	13.78	..	84.42	..
12	10.78	1.75	11.38	..	76.09	..	1.97	12.76	..	85.27	..
13	11.45	1.74	11.59	..	75.22	..	1.98	13.09	..	84.93	..
14	12.53	1.74	14.47	..	71.26	..	1.99	16.54	..	81.47	..
15	12.69	1.71	12.50	..	73.10	.	1.96	14.31	..	83.78	..
16	9.94	1.80	11.69	..	76.57	..	2.02	12.99	..	84.99	..
17	10.00	1.76	11.88	..	76.36	..	1.96	13.20	..	84.84	..
18	12.73	1.38	10.97	..	74 92	..	1.58	12 69	..	85.73	..
19	11.21	1.77	13 56	..	73.46	..	2.00	15 27	..	82.73	..
20	11.93	1.82	14.00	..	72.25	..	2.06	15 88	..	82.06	..
21	11.11	1.70	12.25	..	74.94	..	1 91	13.78	..	84.31	..
22	10.55	1.73	11.15	..	76.57	..	1.93	12.47	..	85.60	..
23	10.12	2.00	13.06	..	74.82	..	2.23	14.51	..	83.26	..
24	11.48	1.69	11.19	..	75 64	..	1.91	12.64	..	85.45	..
25	12.29	1.64	11.88	..	74.19	..	1 87	13.54	..	84.59	..
26	11.30	1.74	10.94	..	76.02	..	1.97	12.33	..	85.70	..
27	12.29	1.79	11.16	..	74.76	..	2.06	12.72	..	85.22	..
28	10.36	1.64	11.81	..	76.19	..	1.83	13.21	..	84.96	..
29	11.19	1.76	12 06	..	74.99	..	1.99	13.59	..	84.42	..
30	11 09	1.64	12.38	..	74.89	..	1.85	13.93	.	84.22	..
31	11.08	1.49	12.25	..	75.18	..	1.68	13.78	..	84.54	..
32	10.43	1.70	12.69	..	75.18	..	1.90	14.17	..	83.93	..
33	10.31	1.60	12.25	..	75.84	..	1.78	13.66	..	84.56	..
34	13.00	1.79	11.37	..	73.84	..	2.05	13.07	..	84.88	..
35	12.99	1 77	10.50	..	74.74	..	2 03	12.07	..	85.90	..
36	10.03	1 59	11.00	..	77.38	..	1.77	12.22	..	86.01	..
37	10.85	1.70	12.03	..	75.42	..	1.91	13.50	..	84.69	..
38	12.21	1.97	12.88	..	72.94	..	2.24	14.66	..	83 10	..
39	13.77	1.72	11.37	..	73 14	..	1.99	13 19	..	84.82	..
40	10.27	1.58	11.25	..	76.90	..	1.7[illegible]	12.54	..	85.70	..
41	10.91	1.46	10 63	..	77.00	..	1.63	11.93	..	86 44	..
†42	7.69	1.91	11.59	1.58	75.17	2.11	2.07	12.56	1.66	81.42	2.29
†43	7.63	1.84	11.59	1.54	74.99	2.41	2.00	12 55	1.67	81.17	2.61
†44	7.49	1.39	9.45	1 69	77 71	2.27	1.50	10.22	1 83	84.01	2.44
†45	8.93	1.58	9 89	1.75	75.41	2.44	1.73	1 .86	1.92	82.81	2.68
†46	8.98	1.57	8.40	1.25	77.52	2.28	1.73	9 23	1.87	85 16	2.51
†47	9 29	1.77	9.45	1.17	76.33	1.99	1.95	10.42	1.29	84.15	2 19
†48	10.08	1.67	12.43	1.56	71.59	2.67	1.86	13.82	1.73	79.62	2 97
†49	9.52	1.57	8.58	1.53	77.11	1.69	1.74	9.47	1.68	85.24	1.87
	10.93	1.70	11.71		75.66		1.91	13.13		84.96	
	13.17	2.09	14.47		81.67						
	7.49	1.38	8.40		71.26						
†50	8.50	1.47	14.70	1.62	71.15	2.56	1.61	16 07	1.77	77.75	2.80
†51	8.79	2.05	15.40	1.49	69.72	2.55	2.25	16.89	1.63	76.43	2.80
†52	8.12	1.57	14.00	2.04	71.78	2.49	1.71	15.23	2.22	78.13	2.71

I. GRAIN AND OTHER SEEDS.

No.	Variety.	Reference.	Analyst
53	Chili Club, Oregon,	Rep. U. S. Dept. Ag. '78, p. 48,	P. Collier,
54	Noah Island, Oregon,	" " " "	"
55	Spring Wheat, Minnesota,	Rep. Mich. Bd. Ag.,'77, p. 350,	R. C. Kedzie,
	Average, (6 analyses),		
	Maximum,		
	Minimum.		
	Average of all wheats, (55 analyses),		
	Oats.		
*1	Probably Illinois "No. 1 White Oats".	Rep.Mid.Ag.Ex.St.,'77–8,p.27,	W. O. Atwater,
2	Conn., 1877, 30 bush. per acre,	" " " "	" "
	Average, (2 analyses),		
	Rye.		
1	White Winter, Penn.,	Rep.U.S. Dept.Ag.,'78, p. 148.	P. Collier,
	Barley.		
1	Nepaul, Cal.,	" " " "	"
	Cow Pea—(Dolichos).		
1	Black Cow Pea. Taken when seeds were ripe,	Rep.N.C.Ag. Ex. St.'79, p.112.	A. R. Ledoux,
2	Yellow Cow Pea. Taken when seeds were ripe,	" " " 113.	" "
	Average, (2 analyses),		

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* These figures differ from those given in *loc. cit.* which have been corrected by the analyst.

I. GRAIN AND OTHER SEEDS.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-free. Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
†53	7.90	1.56	8.14	1.41	78 68	2.33	1.69	8.83	1.53	85.42	2.53
†54	9.64	2.00	9.80	1.92	74.58	2.06	2.21	10.84	2.12	82 55	2 28
55	11.13	1 95	14.00	..	72.92	..	2.20	15.75	..	82.05	..
	9.01	1.76	12.67	..	76 56	..	1.94	13.93	..	84.13	..
	11.13	2.05	15.40	..	82.42	..					
	7.90	1.47	8.14	..	72.92	..					
	10.72	1.70	11.82	..	75.76	..	1.90	13.24	..	84.86	..
1	11.23	2.91	11.54	12.18	57.08	5.06	3.28	13.00	13.72	64.30	5.70
2	12.36	3.03	8.00	12.89	59.02	4.70	3.46	9.13	14.71	67.34	5.36
	11.79	2.97	9.77	12.53	58.06	4.88	3.37	11.07	14.22	65.81	5.53
†1	8.68	1.87	12.07	1.40	73.91	2.07	2.04	13.21	1.54	80.95	2.26
†1	7.23	1.94	13.17	1.55	72.96	3.15	2.09	14.19	1.67	78.65	3.40
1	20.85	2.94	20.08	4.34	50.51	1.28	3.72	25.37	5.48	63.81	1.62
2	19.20	3.31	23.02	5.03	48.07	1.37	4.10	28.50	6.23	59.49	1.68
	20.02	3.13	21.55	4.68	49.29	1.33	3.91	26.93	5.86	61.65	1.65

II. MILL PRODUCTS.

No.	Variety.	Reference.	Analyst.
	Maize Meal.		
1	From Feed Store. Conn.,	Rep. Ct. Ag. Ex. St., '77, p. 56,	S. W. Johnson,
2	New Home-Ground Yellow Flint, Conn.,	“ “ “ “	“ “
3	Western Corn, Conn.,	“ “ “ “	“ “
	Average, (3 analyses),		
	Maximum,		
	Minimum.,		
	Wheat Flour.		
	From Winter Wheat.		
1	Diehl. Mich.,	Rep. Mich. Bd. Ag., '77, p. 350,	R. C. Kedzie,
2	“ “	“ “ “ “	“
3	Soule's, “	“ “ “ “	“
4	Fultz, “	“ “ “ “	“
5	Treadwell, “	“ “ “ “	“
6	Buckeye, “	“ “ “ “	“
7	Asiatic, “	“ “ “ “	“
8	Gold Medal, “	“ “ “ “	“
9	“ “ “	“ “ “ “	“
10	Egyptian red, “	“ “ “ “	“
11	Clawson, “	“ “ “ “	“
12	“ “	“ “ “ “	“
13	Weeks, “	“ “ “ “	“
14	Powers, “	“ “ “ “	“
15	Armstrong, “	“ “ “ “	“
16	Tuscan, “	“ “ “ “	“
	Average, (16 analyses),		
	Maximum,		
	Minimum,		
	From Spring Wheat.		
17	Tea Wheat Flour, Kansas,	Rep. Mich. Bd. Ag., '77, p. 350,	R. C. Kedzie,
18	Grass Wheat, “	“ “ “ “	“
19	Early May, “	“ “ “ “	“
20	Blue Stem, “	“ “ “ “	“
21	Mammoth Spring, “	“ “ “ “	“
	Average, (5 analyses),		
	Maximum,		
	Minimum,		
22	Minnesota Flour, Minnesota,	Rep. Mich. Bd. Ag., '77, p. 350.	R. C. Kedzie,
23	“ “ “	“ “ “ “	“ “
24	Patent Process Flour, Mich.,	“ “ “ “	“ “
*25	“ New Process Flour,” Conn.,	Rep. Mid. Ag. Ex. St. '77–8, p. 25,	W. O. Atwater,
*26	“ No. 1 Flour,”	“ “ “ “	“ “
*27	“ No 2 Flour,”	“ “ “ “	“ “
*28	“ No. 3 Flour,”	“ “ “ “	“ “
	Average of all varieties, (28 analyses),		
	Maximum,		
	Minimum,		
1	Barley Meal,	Rep. Mid. Ag. Ex. St., '77–8, p. 27,	W. O. Atwater,
1	Rice Meal	“ “ “ “	“ “

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* These figures differ from those given in *loc. cit.*, which have been corrected by the analyst.

II. MILL PRODUCTS.

No.	Water.	Ash.	Albu-minoids.	Fiber.	N. fr. Extract.	Fat.	Water-free.				
							Ash.	Albu-minoids.	Fiber.	N. fr. Extract.	Fat.
1	12.91	1.17	8.69	1.79	71.98	3.51	1.84	9.97	2.06	82.60	4.03
2	20.67	1.17	7.81	0.98	66.35	3.07	1.48	9.85	1.17	83.63	3.87
3	21.67	1.16	7.38	1 41	65.88	2.50	1.48	9.42	1.89	84.11	3.19
	18.41	1.16	7.96	1 36	68.02	3.03	1.43	9.75	1.68	83.45	3.69
	21.67	1.17	8.69	1.79	71.98	3.51					
	12.91	1.16	7.38	.93	65.88	2.50					
1	8.28	.62	10.94	..	80.16	..	.63	11.93	..	87.39	..
2	9.29	.65	9.71	..	80.85	..	.72	10 71	..	88.57	..
3	10 65	.62	10.00	..	78.78	..	.69	11.19	..	88.02	.
4	9.69	.66	8.94	..	80.71	..	.73	9.90	..	89.37	..
5	10.46	.66	10.63	..	78.25	..	.73	11.87	..	87.40	..
6	10.66	.63	9.69	..	79.02	..	.71	10.86	..	88.43	..
7	9.66	.64	11.00	..	78.70	..	.71	12.18	..	87.11	..
8	9.56	.67	9.80	..	79.97	..	.74	10.84	..	88.42	..
9	9.66	.64	11 01	..	78.69	..	.71	12.19	..	87.10	..
10	9.71	.66	10.75	..	78.88	..	.73	11.90	..	87 37	..
11	9.93	.63	11.25	..	78.19	..	.70	12.49	..	86.81	..
12	10 69	.64	9.62	..	79.05	..	.72	10.78	..	88.50	..
13	9.10	.65	10.50	..	79.75	..	.72	11.55	..	87.73	..
14	10.15	.48	11.59	..	77.78	..	.53	12.91	..	86 56	..
15	12.61	.63	12.25	..	74.51	..	.72	14,02	..	85.26	..
16	13.43	.72	10.94	..	74.91	..	.83	12.63	..	86.54	..
	10.22	.63	10.54	..	78 61	..	.70	11.74	..	87.56	..
	13.43	.72	12.25	..	80.71						
	9.10	.48	8.94	..	74.51						
17	12.43	.59	13.56	..	73.42	..	.67	15.48	..	83.85	.
18	11.92	.59	13 31	..	74.18	..	.67	15.06	..	84.27	..
19	10.70	.57	11.37	..	77.36	..	64	12.73	..	86.63	..
20	10.99	.57	11 37	..	77.07	..	.64	12.76	..	86.60	..
21	10.96	.69	13.31	..	75.04	..	.78	14.96	..	84.26	..
	11 40	.60	12.58	..	75 42	..	.68	14.19	..	85.13	..
	12.43	.69	13.56	..	77 36						
	10.70	.57	11.37	..	73.42						
22	11.78	.49	12.25	..	75.49	..	.56	13.88	..	85.56	..
23	12.80	.55	12.50	..	74.15	..	.63	14.33	..	85.04	..
24	10.31	.60	10.94	..	78.15	..	.67	12.19	..	87.14	..
25	13.50	0.42	10.92	none	74.04	1.12	0.49	12.63	..	85.58	1 30
26	11.98	0.46	8.71	"	78.11	0.74	0.52	9.83	..	88.76	0.84
27	12.46	0.50	8.56	"	77.92	0.56	0.57	9.75	..	89.04	0.64
28	10.30	0.55	9.59	"	78.52	1.04	0.61	10.69	..	87.54	1.16
	10.84	.60	10.89	..	77.67		.67	12.22		87.11	
	13.50	.72	13.56	..	80.71						
	9.10	.42	8.56	..	73.42						
1	9 85	3.77	12.68	7.00	63.46	3.24	4 18	14.06	7.76	70.41	3.59
1	15.11	6.03	9.25	8.12	59.88	1.61	7.10	10.94	9.56	70.50	1.90

III. By Products and Refuse.

No.	Variety.	Reference	Analyst.
1	Linseed Meal, sold in Conn.,	Rep. Mid. Ag. Ex. St. '77–8, p. 38.	W. O. Atwater,
2	“ “ “	Rep. Conn. Ag. Ex. St., '79, p. 93,	S. W. Johnson,
3	Ohio Round Cakes,	Trans. High. and Ag. Soc., '55, July, p. 50,	Dr. Anderson,
4	Western Cake,		
5	Boston Cake,		
6	North American Cake,		
7	“ “ “		
8	Albany Cake,		
9	Finest American Cake,		
10	“ “ “		
	Average, (10 analyses,)		
	Maximum,		
	Minimum,		
1	Cotton Seed Meal. Sold in Conn.,	Rep. Mid. Ag. Ex. St. '77–8, p. 38,	W. O. Atwater,
2	“ “ “ “ N. Hampshire,	Rep. Dept. Ag., '78, p. 146,	P. Collier,
3	“ “ Cake. “ Conn.,	Trans. Ct. Ag. Soc., 1857, p. 84,	S. W. Johnson,
	Average, (2 analyses),		
	Maximum,		
	Minimum,		
1	Palm Nut Meal. Sold in N. Y. City,	Rep. Mid. Ag. Ex. St., '77, p. 38,	W. O. Atwater,
1	“ Hominy Chops.” Sold in Conn.,	Rep. Ct. Ag. Ex. St., '79, p. 93,	S. W. Johnson,
2	“ “ “ “	“ “ “ “	“ “
1	“ Corn Feed.” Waste product from Starch manufacture. Sold in Conn.,	“ “ “ '78, p 76,	“ “
2	“ Starch Feed,”	Rep. Mid. Ag. Ex, St. '77–8, p. 38,	W. O. Atwater,
	Maize Cob.		
1	Maize Cob Immature Sweet. Harvested Aug. 9, '77. Conn.,	Rep. Ct. Ag. Ex St., '78, p. 72,	S. W. Johnson,
2	Immature Sweet. Harvested Aug. 25, '77. Ct.	“ “ “ “	“ “
3	Sweet. Harvested Sept. 25, '77. Conn.,	“ “ “ “	“ “
4	Ohio Dent. Crop, 1877. Conn.,	“ “ “ “	“ “
5	Norfolk White. N. Carolina.	“ “ “ “	“ “
6	Tuscarora. Crop, 1877. Conn.,	“ “ “ “	“ “
7	Vt. White Cap, “ “	“ “ “ “	“ “
8	Rowley “ “	“ “ “ “	“ “
9	Canada Yellow. Conn.,	“ “ “ “	“ “
10*	Eight Rowed Yellow. Conn.,	Rep. Mid. Ag. Ex St., '77–8, p. 29,	W. O. Atwater,
11	Cob Meal. Maryland,	U. S. Dept. Ag., '78, p. 186,	P. Collier,
	Average 9 analyses),		
	Maximum,		
	Minimum.,		

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* These figures differ from those given in *loc. cit.*, which have been corrected by the analyst.

III. By Products and Refuse.

No.	Water	Ash.	Albu-minoids.	Fiber.	N. fr. Extract.	Fat.	Water-free.				
							Ash.	Albu-minoids	Fiber.	N. fr. Extract.	Fat.
1	9.13	8.16	32.43	7.26	31.45	11.57	8.98	35.69	7.99	34.61	12.73
2	10.76	6.71	35.64	8.86	35.22	2.81	7.50	39.92	9.91	39.52	3.15
3	8.70	5.17	30.94	4.48	37.54	13.17	5.66	33.89	4.91	41.12	14.42
4	9.08	5.49	28.45	5 52	35.79	15.67	6.03	31.26	6.07	39.39	17.25
5	8.80	7.22	28.32	8.37	33.82	13.47	7.91	31.05	9.18	37.10	14.76
6	9.32	7.24	26.00	7.83	38.02	11.59	7.98	28.67	8.63	41.94	12.78
7	9.76	5.73	29.50			9.57	6.32	32.70			10.61
8	8.54	6.85	27.17	..	45.44	16.15	7.49	29.70	..	50.37	17.65
9	9.96	6.48	27.82	..	41.29	10.96	7.20	30.92	..	45.16	12.17
10	9.72	5.56	28.07	15.78	29.05	13.18	6.15	31.09	17.49	32.22	14.60
				12.27	31.20				13.59	34.57	
	9.38	6.46	29.43	*8.80	*34.12	11.81	7.13	32.48	9.70	37.66	13.03
	10.76	8.16	35.64	15.78	38.02	16.15					
	8.54	5.17	26.00	4.48	29.05	2.81					
1	7.24	5.83	41.45	3.08	24.39	18.01	6.28	44.69	3.32	26.29	19.42
2	8.27	7.77	46.37	..	..	..	8.48	50.57	..	..	..
3	6.82	7.80	44.41	11.76	12.74	16.47	8.37	47.65	12.61	13.70	17.67
	7.03	6.82	42.93	7.42	18.56	17.24	7.33	46.17	7.98	19.98	18.54
	8.27	7.80	46.37	11.76	24.39	18.01					
	6.82	5.83	41.45	3.08	12.74	16.47					
1	7.90	3.99	13.53	18.75	41.05	14.78	4.33	14.69	20.36	44.57	16.05
1	13.53	2.44	9.50	3.19	62.02	9.32	2.82	10.88	3.70	71.83	10.77
2	11.56	2.67	9.82	4.79	62.58	8.58	3.01	11.10	5.43	70.78	9.68
1	62.27	.27	5.67	1.58	28.90	1.31	.70	15.03	4.19	76.62	3.46
2	72.19	.12	3.56	3.36	18.78	1.99	.43	12.88	12.05	67.49	7.15
1	(10.10	6.70	8.56	21.40	51.14	2.10)	7.45	9.52	23.80	56.89	2.34
2	(9.02	2.60	3.00	29.68	54.91	0.84)	2.86	3.30	32.56	60.36	.92
3	8.82	1.47	2.69	30.57	55.53	0.92	1.61	2.95	33.54	60.89	1.01
4	8.21	.97	2.56	30.99	56.99	.28	1.06	2.79	33.75	62.10	.30
5	7.18	1.33	1.81	29.80	59.57	.31	1.43	1.94	32.10	64.20	.33
6	8.37	1.57	2.56	30.01	57.15	.34	1.71	2.79	32.75	62.38	.37
7	8.40	.96	2.63	30.47	57.21	.33	1. 5	2.87	33.27	62.45	.36
8	8.05	.98	1.81	32.39	56.54	.23	1.07	1.97	35.21	61.50	.25
9	7.52	2.14	2.35	29.76	57.72	.51	2.31	2.54	32 1	62.43	.55
10	11.45	1.36	1.23	38.26	47.62	.08	1.52	1 38	43 21	53.80	.09
11‡	14.42	1.12	2.33	36.10	45.31	.72	1.31	2.72	42.18	52.95	.84
	9.16	1.32	2.22	32.04	54.85	.41	1·45	2.44	35.31	60.35	.45
	14.42	2.14	2.69	38.26	59.57	.92					
	7.18	.96	1.23	29.76	45.31	.08					

* Average of 3 analyses.

III. BY PRODUCTS AND REFUSE.

No.	Variety.	Reference.	Analyst.
	Wheat Bran and Middlings.		
1	“Coarse Wheat Feed,” from White Wheat, Conn.,	Rep. Ct. Ag. Ex. St., '77, p. 59,	S. W. Johnson,
2	“Coarse Wheat Feed,” from Red Wheat, Conn.,	“ “ “ “	“ “
3	Western Wheat Bran, Conn.,	“ “ “ “	“ “
4	“Fine Feed,”—Ground Bran, Conn.,	“ “ “ “	“ “
5	Wheat Middlings, Conn.,	“ “ “ “	“ “
6	“Wheat Shorts,” Conn.,	Rep. Mid. Ag. Ex. St. '77–8, p. 26,	W. O. Atwater,
7	“No. 2 Middlings,” “	“ “ “ “	“ “
8	“No 1 Middlings,” “	“ “ “ “	“ “
9*	“Purified Middlings,” Conn.,	“ “ “ “	“ “
10	“St. Louis Shorts,” 1872,	Bull. Bussey Inst., '74, p. 27,	F. H. Storer,
11	“Illinois Shorts,”	“ “ “ “	“ “
12	“Michigan Shorts,”	“ “ “ “	“ “
13	“St. Louis Middlings,”	“ “ “ “	“ “
14	“Illinois Middlings,”	“ “ “ “	“ “
15	“St. Louis Ship Stuff,”	“ “ “ “	“ “
16	Bran. Mich.,	Rep. Mich. Bd. of Ag., '78, p. 410,	R. C. Kedzie,
17	“Shorts,” “	“ “ “ “	“
18	“Middlings,” “	“ “ “ “	“
19	“Mill Feed,” “	“ “ “ “	“
	Average, (18 analyses),		
	Maximum,		
	Minimum,		
	Rye Bran.		
1	Sold in Conn.,	Rep. Ct. Ag. Ex. St., '78, p. 75,	S. W. Johnson,
2	“ “	Rep. Mid. Ag. Ex. St., '77, p. 27,	W. O. Atwater,
	Average, (2 analyses),		
	Malt Sprouts.		
1	Sold in Conn.,	Rep. Ct. Ag. Ex. St., '77, p. 50.	S. W. Johnson,
	Brewers Grains.		
1	Sold in New York, 1 bush. = 70 lbs.,	Rep. Mid Ag. Ex. St., '77–8, p. 38,	W. O. Atwater,
2	“ “ 1 “ = 40 lbs.,	Rep. Ct. Bd. Ag., '72, p. 423,	S. W. Johnson,
3	“ “	Rep. Dept. Ag., '78, p. 137,	P. Collier,
	Date Stones.		
1	From Light Colored, Sugar Cured Dates,	Bull. Bussey Inst., '76, p. 375,	F. H. Storer,
2	From Dark Colored, Molasses Cured Dates	“ “ “ “	“
1	*Peach Stones,*	“ “ “ “	“
	Prune Stones.		
1	From French Prunes,	“ “ “ “	“

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* Has more nearly the composition of flour.

III. BY PRODUCTS AND REFUSE.

No.	Water.	Ash.	Albu-minoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free.				
							Ash.	Albu-minoids.	Fiber.	N. fr. Extract.	Fat.
1	10.87	5.75	13.63	7.56	58.92	3.27	6.46	15.30	8.47	66.18	3.64
2	11.14	5.99	12.13	9 31	58.36	3.07	6.73	13.65	10.47	65.65	3.50
3	12.12	6.38	13 50	8.79	55.90	3.36	7.21	15.36	10.11	63.48	3.84
4	10.47	5.56	13.88	7.98	58.88	3.23	6.22	15.51	8.92	65.73	3.62
5	10.56	3.45	14 22	5.35	62.90	3.52	3.86	15.91	5.97	70.32	3.94
6	11.31	3.94	13.91	6.34	62.10	2.50	4.44	15.68	7.04	70.02	2.82
7	12 27	4.06	13.33	7.45	61.21	2.68	4.63	15.19	8.50	68.63	3.05
8	11.32	1.39	10.48	3.88	70.86	2.07	1.57	11.82	4.38	79.90	2.33
(9	12.35	0.50	10.40	none	75.50	1.24)	0.57	11.87	..	86.14	1.42
10	12.23	4 53	12.06	7.12	60.05	4.01	5.17	13.73	8.11	68.44	4.55
11	10 96	4.24	11.13	7.29	62.32	4.06	4.76	12.51	8.20	69.96	4.57
12	11.77	4.06	12.75	10.47	56.30	4.65	4.59	14.46	11.87	63.80	5.28
13	12.08	1.57	11.06	3.57	69.21	2.51	1.79	12.58	4.06	78.72	2.85
14	13.30	2 71	10.13	5.35	64.80	3.71	3.12	11.68	6.17	74.75	4.28
15	11.81	2.25	11.12	5.59	66.46	2.77	2.55	12.67	6.34	75.32	3.14
16	11.65	5.63	14.00	9.13	55.56	4.03	6.37	15.83	10.31	62.93	4.56
17	11.26	3.95	15.13	7.46	57.35	4.85	4.46	17.07	8.41	64.59	5.47
18	11.27	2.11	13.75	3.47	65.71	3.69	2.38	15.49	3.91	74.06	4.16
19	11.29	2.24	11.38	5.22	65.52	4.35	2.50	12.83	5.88	73.89	4.90
	11.53	3.82	12.64	6.74	61.81	3.46	4.31	14.28	7.60	69.90	3.91
	13.30	6.33	14.22	10.47	70 86	4.85					
	10.47	1.39	10.13	3.47	55.56	2.07					
1	10.30	3.54	16 81	4.07	62 68	2.60	3.95	18.74	4.54	69.87	2.90
2	12.88	2.89	12 58	2.54	66.96	2.15	3.32	14.44	2.92	76.85	2.47
	11.59	3.21	14.69	3.31	64.82	2.38	3.63	16.62	3.74	73.32	2.69
1	11.55	6.68	25.91	9.30	45.47	1.09	7.54	29.29	10.52	51.52	1.13
1	75.24	0.29	5.94	3.87	13.19	1.47	1.18	24.06	15.62	53.20	5.92
2	78.50	1.07	4.69	3.11	12.63	..	4.98	21.81	14.46	58	.72
3‡	10.24	2.70	21.66	14.88	43.86	6.66	3.01	24.11	16.57	48.89	7.42
1	7.71	1.05	5.16	24.07	53.06	8.95	1.13	5.60	26.09	57.59	9.69
2	10.63	1.02	5.75	22.06	52.29	8.05	1.14	6.45	24.73	58.65	9.03
1	5.53	0.36	0.58	70.63	22.81	0.09	.38	.61	74.73	24.18	.10
1	10.96	0.40	0.31	48.74	38.87	0.72	.45	.35	54.76	43.63	.81

IV. Hay.

No.	Variety.	Reference.	Analyst.
	Timothy Hay (Phleum pratense.)		
1	Crop 1876. Maine. Clayey loam, heavy, wet. Since '72 in grass. Well headed out,	Rep. Mid. Ag. Ex. St. '77–8, p. 81,	W. O. Atwater,
2	Crop 1876, Maine. Clayey loam, heavy, wet. Since '72 in grass. In full blossom,	" " " "	" "
3	Crop 1876, Maine. Clayey loam, heavy, wet. Since '72 in grass. Past blossom,	" " " "	" "
4	Crop 1876, Maine. Clayey loam, heavy, wet. Since '72 in grass. Nearly ripe,	" " " "	" "
5	Crop of 1879. Conn.,	Rep. Ct. Ag. Ex. St., '79, p. 80,	S. W. Johnson,
6	N. Hampshire July 1, 1878,	" " " "	" "
7	" " 11, 1878,	" " " "	" "
8	Crop 1877. Conn.,	" " " "	" "
9	Crop 1877. Conn.,	" " " "	" "
	Average, (9 analyses),		
	Maximum,		
	Minimum,		
	Hay, mostly timothy and red-top.		
1	Crop 1879. Conn.,	Rep. Ct. Ag Ex. St., '79, p. 80,	S. W. Johnson,
2	" 1879. "	" " " "	" "
3	" 1877. "	" " " "	" "
4	" 1877. "	" " " "	" "
	Hay, mostly timothy and blue grass.		
5	Crop 1877. Conn.,	Rep. Ct. Ag. Ex. St., '79, p. 80,	S. W. Johnson,
	Hay, mixed meadow grasses.		
6	Crop 1877. Conn.,	Rep. Ct. Ag. Ex. St., '79, p. 80,	S. W. Johnson,
7	" 1877. "	" " " "	" "
	Average (7 analyses),		
	Maximum,		
	Minimum,		
	Hay, containing much clover.		
1	Crop 1879. Conn.,	Rep. Ct. Ag. Ex. St., '79, p. 80,	S. W. Johnson,
2	" 1879. "	" " " "	" "
3	" 1877. "	" " " "	" "
4	" 1877. "	" " " "	" "
5	" 1877. "	" " " "	" "
	Average (5 analyses),		
	Maximum,		
	Minimum,		
	Clover Hay, (Trifolium pratense).		
1	Maine. Crop 1876. Poor loam, well manured, cut just before blossom,	Rep. Mid. Ag. Ex. St., '77–8, p. 82,	W. O. Atwater,
2	Maine. Crop 1876. Poor loam, well manured, cut in full blossom,	" " " "	" "

IV. HAY.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free. Ash.	Water-Free. Albuminoids.	Water-Free. Fiber.	Water-Free. N. fr. Extract.	Water-Free. Fat.
1	12.5*	4.10	8.37	28.90	44.42	1.71	4.69	9.57	33.03	50.74	1 95
2	12.5*	3 81	6.23	29.12	46.63	1.71	4.35	7.12	33.28	53.29	1.96
3	12.5*	3.53	6.18	29.56	46.70	1.53	4.15	7.06	33.78	53.26	1.75
4	12.5*	3.22	5.86	31.00	45.69	1.73	3.65	6 81	35.43	52.19	1.97
5	14.3*	3.27	4.88	32.81	43.29	1.45	3.80	5.69	38.28	50.55	1.68
6	14.3*	4.10	6.20	25.30	48.10	2.00	4.78	7.24	29.53	56.12	2.33
7	14.3*	3.80	5.30	27.50	47.20	1.90	4.43	6.19	32.09	55.07	2.22
8	14.3*	4.38	5.57	29.48	45.19	1.08	5.11	6.50	34.40	52.74	1.25
9	14.3*	4.60	6.90	26.80	45.40	2.00	5.37	8.05	31.28	52 99	2.33
	13.50	3.87	6.16	28.94	45.85	1.68	4.47	7.11	33.45	53.03	1.94
	14.30	4.60	8.37	32.81	48.10	2.00					
	12.50	3.22	4.88	25.30	43.29	1.08					
1	14.3*	5.57	7.85	24.72	45.08	2.48	6.50	9.15	28 85	52.60	2.90
2	14.3*	6.86	8.97	28.45	39.20	2.22	8.00	10.46	33.20	45.74	2.60
3	14.3*	4.81	6.02	26.54	46.88	1.45	5.61	7.02	30.98	54.71	1.68
4	14.3*	4.90	7.50	26.30	45.30	1.70	5.72	8.75	30.70	52.85	1.98
5	14.3*	4.70	7.00	26.90	45.40	1.70	5.48	8.17	31.41	52.96	1.98
6	14.3*	4.23	7.02	27.82	45.00	1.63	4.93	8.18	32.47	52.52	1.90
7	14.3*	4.56	6.50	25.89	47.33	1.43	5.31	7.57	30.24	55.23	1.65
	14.30	5.09	7.26	26.66	44.89	1.80	5.93	8.47	31.10	52.40	2.10
		6.86	8.97	28.45	47.33	2.48					
		4.23	6.02	24.72	39.20	1.43					
1	14.3*	5.30	14.42	19.66	43,23	3.09	6.19	16.82	22.95	50.54	3.60
2	14.3*	6.49	11.62	23.06	42.07	2.46	7.57	13.56	26.90	49.09	2.88
3	14.3*	5.10	10.60	24.90	42.40	2.70	5.95	12.37	29.06	49.47	3.15
4	14.3*	4.74	9.06	28.19	42.21	1.50	5.48	10.57	32.89	49.31	1.75
5	14.3*	5.10	9.00	24.90	44.90	1.80	5.95	10.51	29.06	52.38	2.10
	14.30	5.34	10.94	24.14	42.97	2.31	6.24	12.77	28.17	50.13	2.69
		6.49	14.42	28.19	44.90	3.09					
		4.74	9.00	19.66	42.07	1.50					
1	14.3*	7.15	12.23	23.79	41.06	1.47	8.34	14.27	27.75	49.93	1.71
2	14.3*	6.56	11.56	23.82	41.72	2.04	7.65	13.48	27.79	48.70	2.38

* Reckoned by the analyst to a uniform water content. No. 3 Timothy, corrected by the analyst. Figures different from those given in *loc. cit.*

IV. HAY.

No.	Variety.	Reference.	Analyst.
3	Maine. Crop 1875. Poor loam, well manured, cut when heads began to brown,	Rep. Mid. Ag. Ex. St. '77-8, p. 32,	W. O. Atwater,
4	Maine. Crop 1875. Poor loam, well manured, nearly ripe, ...	“ “ “ “	“ “
	Average, (4 analyses), ...		
	Maximum, ...		
	Minimum, ...		
	Hay from Hungarian Grass.		
1	Conn. Crop 1876. Cut July 17. Heads partly filled. Seeds but little developed,	Rep. Mid. Ag. Ex. St. '77-8, p. 33,	W. O. Atwater.
2	Conn. Crop 1876. Cut Aug. 3. Heads well filled. Seeds Soft, ...	“ “ “ “	“ “
3	Conn. Crop 1876. Cut Aug 18. Seeds falling out, ...	“ “ “ “	“ “
4	Conn. Crop 1877, ...	Rep. Ct. Ag. Ex. St., '79, p. 80,	S. W. Johnson,
	Average, (4 analyses), ...		
	Maximum, ...		
	Minimum, ...		
	Low Meadow Hay.		
1	Cut from low meadows in Ct. Chiefly Carex stricta, Lamarck. C. stellulata v. scirpoides, Gr., and Eleocharis tenuis Schultes.	Rep. Ct. Bd. Ag., '72, p 422,	S. W. Johnson,
2	Cut June 11, '73. Small sample gathered by hand. Mass. Carex stricta. Going to seed. Many seeds included, ...	Bull. Bussey Inst., '75, p. 345,	F. H. Storer,
3	Cut June 16, '73. Small sample gathered by hand. Mass Carex stricta, ...	“ “ “ “	“
4	Cut Aug., 1874. Mass, “Bog hay,” Carex stricta? No seeds or flowers, ...	“ “ “ “	“
5	Cut 1874. Mass. “Bog hay,” Carex stricta, ...	“ “ “ “	“
6	Cut Dec. 26, 1874. Mass. “Bog hay,” Carex stricta. Dead and weather beaten, ...	Bull. Bussy Inst., '75, p. 345,	F. H. Storer,
7	Swale Hay 1878. N. Hampshire, ...	Rep. U. S. Dept. Ag., '78, p. 146,	P. Collier,
8	Conn. 1877, ...	Rep. Ct. Ag. Ex. St., '79, p. 80,	S. W. Johnson,
9	“ 1877, ...	“ “ “ “	“ “
	Average, (9 analyses), ...		
	Maximum, ...		
	Minimum, ...		
	Salt Marsh Hay		
1	Crop 1872. Mass. Brizopyrum spicatum, Spartina juncea and some Glyceria maritima, ...	Bull. Bussy Inst., '75, p. 341,	F. H. Storer,
2	Crop 1874. Mass. Brizopyrum spicatum, some Juncus bulbosus, ...	“ “ “ “	“
3	Crop 1874. Mass. Mostly Brizopyrum spicatum, some Juncus bulbosus, ...	“ “ “ “	“
4	Crop 1874. Mass. Mostly Spartina juncea,	“ “ “ “	“

IV. HAY.

No.	Water.	Ash.	Albu-minoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free. Ash.	Water-Free. Albu-minoids.	Water-Free. Fiber.	Water-Free. N fr. Extract.	Water-Free. Fat.
3	14.3*	6.29	11.25	25.60	41.01	1.55	7.34	13.13	29.87	47.86	1.80
4	14.3*	5.57	8.87	27.22	41.98	2.06	6.50	10.35	31.75	49.00	2.40
	14.3	6.39	10.98	25.10	41.45	1.78	7.46	12.81	29.30	48.37	2.06
	14.3	7.15	12.28	27.22	41.98	2.06					
	14.3	5.57	8.87	23.79	41.01	1.47					
1	16.7*	7.17	10.67	28.91	34.85	1.70	8.60	12.81	34.69	41.76	2.04
2	16.7*	4.28	8.03	27.55	41.91	1.53	5.13	9.63	33.06	50.35	1.88
3	16.7*	5.29	5.72	28.94	41.94	1.42	6.34	6.87	34.73	50 36	1.70
4	16.7*	6.34	6.09	27.17	42.40	1.30	7.57	7.35	32.60	50.97	1.51
	16.7	5.77	7.63	28.14	40.28	1.48	7.00	9.16	33.76	48.31	1.77
	16.7	7.17	10.67	28.94	42.40	1.70					
	16.7	4.28	5.72	27.30	34.85	1.30					
1	14.3	3.3	7.8	31.6	39.9	3.1	3.85	9.10	36.87	46.56	3.62
2	7.46	6.52	10.41	33.60	39.80	2.21	7.05	11.25	36 23	43.08	2.39
3	7.33	6.17	9.38	33.91	41.08	2.13	6.67	10 11	36.57	44.35	2.30
4	7.96	5.65	6.31	33.55	43.53	3.00	6.14	6.86	36.44	47.30	3 26
5	8.38	5.43	7.44	33.30	43.53	1.92	5.80	8.12	36.36	47.63	2.09
6	9.32	4.42	4.63	39.99	40.90	0.74	4.87	5.10	44:09	45.12	.82
7	6.41	6.33	7.07	21.39	55.17	3.63	6.76	7.55	22 85	58.96	3.88
8	14.3	5.40	6.70	26.20	46.10	1.30	6.30	7.80	30.58	53.81	1 51
9	14.3	8.56	7.27	23.22	44.49	2.16	9.97	8.47	27.10	51.94	2.52
	9.97	5.76	7.44	30.75	43 84	2.24	6.39	8.22	34.15	46.76	2.48
	14.30	6.52	10.41	39.99	55.17	3.63					
	6.41	3.30	4.63	21.39	39.80	0 74					
1	7.93	6.29	7.09	31.40	44.39	2.90	6 84	7 69	34.09	48.23	3.15
2	8.91	7.79	7.53	32.90	39.73	3.14	8.56	8.25	36.11	43.72	3.45
3	7.84	7.10	7.79	33.84	40 66	2.77	7 63	8.46	36 69	44.10	3.00
4	8.70	7.51	4.88	28.71	48.52	1.68	8.22	5.35	31.43	53.16	1.84

* Reckoned by the analyst to a uniform water content. No. 3 Timothy corrected by the analyst. Figures different from those given in *loc. cit.*

IV. HAY.

No.	Variety.	Reference.	Analyst.
5	Crop 1874. Mass. Almost all Spartina juncea,...........................	Bull. Bussey Inst., '75, p. 341,	F. H. Storer,
6	Crop 1872. Mass. Pure Spartina stricta var. alterniflora, ...	" " " p. 342,	"
7	Crop 1874. Mass. Pure Spartina stricta var. alterniflora,..................	" " " "	"
8	1874. Mass. Mostly spartina stricta. Sample not taken from a *crop*........	" " " "	"
9	Mass. Juncus bulbosus. Upper parts of stalks and empty seed vessels. Sample not taken from a *crop*, ...	" " " "	"
10	Mass. Juncus bulbosus. Many seeds on the stalks,........	" " " "	"
	Average. (10 analyses), ...		
	Maximum, ...		
	Minimum,........		
	Hay from Various Grasses.		
1	Calamagrostis Canadensis, Blue Joint Grass, June '76. Mass. In blossom,..	Bull. Bussey Inst., '77, p. 131,	F. H. Storer,
2	Calamagrostis Canadensis, Blue Joint Grass, July '76. Mass. In blossom,..	" " " "	"
	Average, (2 analyses), ...		
1	Phalaris arundinacea, Reed Canary Grass, June '76, Mass. In bud, ...	Bull. Bussey Inst., '77, p. 132,	F. H. Storer,
2	Phalaris arundinacea, Reed Canary Grass, June '76, Mass. In bud, ...	" " " "	"
	Phalaris arundinacea, Leaves. 41.29 per cent. of the whole, ...	4th Rep. Mass. Bd. Ag., '56, p. 83,	E. N. Horsford,
	Stalks 52.12 per ct., ...	" " " "	"
	Joints 6.59 per ct.....................	" " " "	"
3	Composition of the whole, ...	" " " "	"
	Average, (3 analyses), ...		
1	Hierochloa borealis. Vanilla Grass. Ill.	Rep. U.S. Dept. Ag., '78, p. 184	Peter Collier.
1	Eleusine Indica. Wire grass. Texas, Ala., Miss., Ga.,.......................	" " " "	
2	Eleusine Indica. Wire grass. Texas, Ala., Miss., Ga., ...	" " " "	
3	Eleusine Indica. Wire grass. Texas, Ala., Miss., Ga., ...	" " " "	
1	Uniola latifolia. Fescue grass,.........	" " " "	
1	Cynodon dactylon. Bermuda grass. Ala., Miss.,............	" " " "	
2	Cynodon dactylon. Bermuda grass. Ala., Miss., ...	" " " "	
1	Sporobolus Indicus. Smut grass. Miss..	" " " "	
1	Andropogon Virginicus. Broom Grass. Texas, ...	Rep. U.S. Dept. Ag., '78, p. 184,	P. Collier,
1	Andropogon scoparius. Ala.,.........	" " " "	"
1	Poa pratensis, Ky. Blue Grass. Wis., ..	" " " "	"
1	" serotina. Fowl Meadow Grass. Wis.,	" " " "	"

IV. HAY.

No.	Water.	Ash.	Albu-minoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free.				
							Ash.	Albu-minoids.	Fiber.	N. fr. Extract.	Fat.
5	8.61	5.97	4.38	37.91	41.30	1.83	6.54	4.80	41.46	45.20	2.00
6	11.70	9.84	4.33	30.54	41.30	2.29	11.15	4.90	34.58	46.77	2.60
7	17.47	9.56	5.55	30.01	35.15	2.26	11.59	6.72	36.36	42.60	2.78
8	18.61	11.81	5.38	27.64	34.07	2.49	14.51	6.61	33.96	41.86	3.06
9	7.17	4.90	7.39	35.90	42.55	2.09	5.28	7.96	38.69	45.82	2.25
10	10.25	5.48	6.18	30.43	45.15	2.51	6.11	6.89	33.91	50.29	2.80
	10.72	7.62	6.05	31 98	41.29	2.39	8.58	6.78	35.76	46.25	2.68
	18.61	11.81	7.79	37.91	48.52	3.14					
	7.17	4.90	4.83	27.64	34.07	1.68					
1	9.77	4.19	6.72	40 00	37.18	2.14	4.65	7.45	44.84	41.23	2.38
2	9.22	4.30	5.59	39.47	39.36	2.06	4.74	6.15	43.48	43.58	2.25
	9.49	4.25	{6.15	39.74	38.27	2.10	4.69	6.80	43.92	42.27	2.32
1	9.56	5.99	10.00	32.90	38.86	2.69	6.63	11.06	36.39	42.93	2.99
2	10.11	8.18	11.09	33.20	34.06	2.36	9.10	12.32	36.92	37.83	3.78
	10.98	8.85	7.06		72 96						
	9.58	3.58	.50		86.38						
	10.72	3.50	2.81		82.91						
3	10.42	5.31	3.44		80 83		5.93	3.88		90.24	
	10.03	6.49	8.17		75.31		7.22	9.07		83.71	
*1							8.41	14.81	23.30	49.86	4.12
*1							9.12	13.72	31.29	43.71	2.16
*2							6.83	13.28	22.38	55.94	2.07
*3							7.07	12.23	21.58	56.61	2.56
*1							11.38	11.29	38.67	35.48	3.28
*1							6.16	11.15	24.55	55.92	2.22
*2							7.96	13.59	23.57	53.29	1.59
*1							6.19	12.46	25.91	52.14	3.30
*1							6.44	13.00	33.78	45.12	1.71
*1							8.90	6.21	24.91	63.39	1.59
*1							5.18	11.54	27.94	52.48	2.86
*1							4.74	8.91	25.62	57.25	3.48

* These analyses of grass were reduced by the analyst to a water-free basis. The original water content was not given.

IV. HAY.

No.	Variety.	Reference.	Analyst.
1	Dactyloctenium Aegyptiacum. Willd. Egyptian Grass. Ga.,	Rep. U.S.Dept. Ag.,'78,p.184,	P. Collier,
1	Panicum sanguinale. Crab Grass. Miss., Ala.,	“ “ “ “	“
1	Panicum jumentorum. True Guinea Grass,	“ “ “ “	“
1	“ obtusum, Texas,	“ “ “ “	“
1	“ virgatum. Tall Panic Grass. Texas or Ala.,	“ “ “ “	“
2	Panicum virgatum. Tall Panic Grass. Texas or Ala.,	“ “ “ “	“
1	Panicum Texanum. Texas Millet. Texas,	“ “ “ “	“
1	“ crus-galli. Barn Yard Grass. Texas, Ala., Miss.,	“ “ “ “	“
1	Panicum filiforme. Slender Crab Grass, Ala.,	“ “ “ “	“
1	Sorghum halapense. Johnson Grass. Ala.,	“ “ “ “	“
1	“ avenaceum. Indian Grass,	“ “ “ “	“
1	Muhlenbergia diffusa. Drop Seed. Tex.,	“ “ “ “	“
1	Bromus unioloides. Schrader's Grass,	“ “ “ “	“
1	Bromus carinatus. Brome Grass. Ill.,	“ “ “ “	“
1	Agrostis exarata. Brown top. Wis.,	“ “ “ “	“
1	Paspalum laeve. Water Grass. Texas,	“ “ “ “	“
1	Setaria setosa. Bristly Fox Tail.—Bristle Grass, Texas,	“ “ “ “	“
1	Leptochloa mucronata. Feather Grass. Ala.,	“ “ “ “	“
1	Tripsacum dactyloides. Game Grass, Miss.,	“ “ “ “	“
1	Tricuspis seslerioides. Tall Red Top. Texas,	“ “ “ “	“

V. VARIOUS PLANTS AND WEEDS.

Air Dry.

1	Juncus effusus. Aug., 1874, Mass.,	Bull. Bussey Inst., '75, p. 351,	F. H. Storer,
2	Ranuculus acris. June, 1873, Mass.,	“ “ “ “	“ “
3	Leucanthemum vulgare. In full flower. June, 1872, Mass.,	“ “ “ “	“ “
4	Osmunda regalis. 1874, Mass.,	“ “ “ “	“ “
5	Desmodium. Beggar Lice,	Rep. U.S. Dept. Ag.,'78, p.184,	P. Collier,
6	Lespedeza striata. Japanese Clover. Ala.,	“ “ “ “	“
7	Lathyrus maritimus. Mass.,	Bull. Bussey Inst., '75, p. 351,	F. H. Storer,
8	“ “ Me.,	“ “ “ “	“ “
9	“ “ Mass.,	“ “ “ “	“ “
	Fresh.		
1	Leontodon taraxacum. Dandelion. May, '75, Mass.,	Bull. Bussey Inst., '77, p. 117,	“ “
2	Urtica dioica. Nettle. Mass., May, '76,	“ “ “ 119,	“ “
3	Plantago major. Common Plantain. Mass. May, '76,	“ “ “ 123,	“ “
4	Portulaca oleracea. Purslane. Mass., July, '76,	“ “ “ 126,	“ “
5	Chenopodium album. Pig Weed. Mass., Aug., '76,	“ “ “ 127,	“ “
6	Equisetum arvense. Scouring rush. Fertile stems. April, '76,	“ “ '78, p. 167,	“ “
7	Equisetum arvense. Sterile stems. May, '76,	“ “ “ “	“ “

IV. HAY.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free. Ash.	Water-Free. Albuminoids.	Water-Free. Fiber.	Water-Free. N. fr. Extract.	Water-Free. Fat.
*1							6.90	9.01	17.48	64.65	1.96
*1							10.68	9.99	32.80	43.64	2.89
*1							8.37	8.95			
*1							8.75	7.28	31.76	49.04	1.58
									33.32	48.38	2.27
*1							4.84	5.01	37.38	51.07	1.70
*2							3.56	4.58	28.87	60.07	1.92
*1							6.63	5.61			
									27.68	57.54	2.54
*1							10.14	4.14	32.27	51.34	2.11
*1							4.65	3.32	26.78	63.71	1.54
*1							4.85	13.18			
*1							5.63	3.29	25.15	53.96	2.86
*1							7.61	10.06	36.70	52.71	1.67
*1							7.78	12.45	23.37	57.14	1.82
*1							10.31	9.98	24.31	52.23	3.23
*1							5.62	10.65	26 90	50.11	2.70
*1							6.43	8.14	24.59	56.83	2.81
									27.72	55.95	1.76
*1							6.71	8.61	32.76	50.41	1.51
*1							8.98	7.80	32.16	48.98	2.08
*1							5.96	8.62	26.59	56.43	2.40
*1							4.55	6.32	37.86	49.22	2.50

V. VARIOUS PLANTS AND WEEDS.

1	6.88	2.63	6.75	41.48	42.26		2.88	7.25	44.44	45.	48
2	8.24	5.21	10.66	30.70	41.55	3.64	5.68	11.60	33.44	45.82	3.96
3	10.87	6.44	7.00	31.00	42.27	2.42	7.23	7.86	34.79	47.51	2.71
4	8.23	6.73	7.38	25.59	49.10	2.97	7.83	8.04	27.88	53.52	3.23
*5							7.56	22.22	25.39	48.04	2.79
*6							4.33	15.11	23.77	52.39	4.40
7	7.88	6.99	23.25	29.35	27.58	4.95	7.59	25.24	31.87	29.92	5.38
8	7.18	6.54	14.66	30.02	36.64	4.96	7.05	15.80	32 35	39.46	5.34
9	7.79	8.60	18.19	26.99	35.39	3.04	9.32	19.74	29.28	38.37	3.29
1	85.54	1.99	2.81	1.52	7.45	0.69	13.74	19.38	10.52	51.59	4.77
2	82.44	2.30	5.50	1.96	7.13	0.67	13.14	31.32	11.15	40.56	3.83
3	81.44	2.16	2.65	2.09	11.19	0.47	11.64	14.29	11.27	60.27	2.53
4	92.61	1.56	2.24	1.03	2.16	0.40	21.06	30.25	13.96	29.38	5.35
5	80.80	3.02	3.94	2.55	8.93	0.76	15.76	20.61	18.25	46.44	3.94
6	87.28	1.60	1.86	1.87	7.05	0.84	12.55	14.62	14.72	55.48	2.68
7	85.63	1.74	3.34	2.49	6.04	0.76	12.12	23.26	17.31	42.00	5.31

VI. STRAW AND COARSE FODDER.

No.	Variety.	Reference.	Analyst.
	Oat Straw.		
1	The Straw from Oats, No. 2. Conn.,....	Rep.Mid.Ag.Ex.St.,'77–8,p.37,	W. O. Atwater,
	Rye Straw.		
1	Conn. Raised on heavy loam. 16 bush. rye per acre, ...	Rep.Mid.Ag.Ex.St.,'77–8,p.37,	W. O. Atwater,
	Buckwheat Straw.		
1	Conn., ...	Bull. Bussey Inst., '77, p. 54.	F. H. Storer,
2	“	“ “ “ “	“ “
	Cow Pea Vines (Dolichos).		
1	Equal parts of black and yellow Cow Pea Vines, ...	Rep.N.C.Ag. Ex.St.,'79, p. 115,	A. R. Ledoux,
	Maize Fodder and Stover (Fresh).		
1	Cut July 25, before tassels appeared,. } Medium or large var. Sweet Corn plant'd June 1,'77, in good garden soil. Hills 2½ ft. apart in row. Rows 3 ft. apart.	Rep. Ct. Ag. Ex. St., '78, p. 60,	S. W. Johnson,
2	Cut Aug. 9, in full silk,............	“ “ “ “	“ “
3	Cut Aug. 25, kernels full size, ...	“ “ “ “	“ “
4	Cut Sept. 25. Nearly “dry.”	“ “ “ “	“ “
5	*Southern White Fodder. Conn. Cut when tassels began to appear, ...	Rep.Mid.Ag.Ex.St.'77–8,p.25,	W. O. Atwater,
6	Southern White Fodder. Conn. Cut when tassels began to appear. Sown thicker than 5,......	“ “ “ “	“ “
7	Southern White Fodder. Conn. Cut two weeks later than 5,..................	“ “ “ “	“ “
8	Fodder, Norfolk White. Conn. On long tilled ground with stable manure. Cut Sept. 1, Fresh, ...	Am.Jour.Sci.& Arts,'77, p 203,	S. W. Johnson,
9	Fodder, Norfolk White. Conn. Not long tilled. Cut Sept. 1, Fresh, ...	“ “ “ “	“ “
	Average (9 analyses),............		
	Maximum, ...		
	Minnimum, ...		
	Maize Fodder and Stover (Field cured).		
1	Ohio Dent, 1877. Conn., ...	Rep. Ct. Ag. Ex. St., '78, p. 60,	S. W. Johnson,
2	Norfolk White. Conn. On land long tilled,	Am.Jour.Sci.&Arts,'77, p. 203,	“ “
3	“ “ Conn. On land not long tilled,	“ “ “ “	“ “
4	White Flint Corn. Conn., 1877,... ...	Rep. Ct. Ag. Ex. St.,'79, p. 80,	“ “
	Average (3 analyses), ...		
	Maximum, ...		
	Minimum, ...		

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* The statements with regard to Nos 5, 6 and 7, differ from those given in *loc. cit.*, corrected by the analyst.

VI. STRAW AND COARSE FODDER.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free.				
							Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
1	12.50*	1.81	2.30	55.96	26.42	[1.00	2 07	2.63	68.96	30.19	1.15
1	12.50*	8.03	6.89	34.20	35.70	2.68	9.18	7.88	39.08	40.82	3.04
1	10.35	4.94	4.38	46.83	32.08	1.42	5.52	4.91	52.28	35.71	1.58
2	10.39	5.16	3.33	44.93	34 49	1.70	5.76	3.72	50.12	38.51	1.90
1	72.81	2.00	1.85	15.27	7.86	0.21	7.37	6.81	56.27	28.88	0.78
1	92.908	.980	.866	1.903	3.198	.145	13.82	12.22	26.84	45.08	2.04
2	88.289	1.269	1.310	3.227	5.736	.169	10.84	11.19	27.45	49.08	1.44
3	90.480	1.104	.864	2.694	4.719	.139	11.59	9.08	28.30	49.57	1.46
4	80.740	2.334	1.588	5.939	9.207	.244	12.12	7.89	30.78	47.94	1.27
5	85.70*	0.94	1.27	4.60	7.28	0.21	6.55	8.87	32.17	50.91	1.50
6	85.70*	1.23	1.20	4.95	6.73	0.18	8.62	8.44	34.66	46.98	1.30
7	85.70*	1.00	1.48	4.31	7.37	0.14	6.97	10.38	30.16	51.48	1.01
8	87.18	0.84	0.88	4.38	6.44	0.23	6.57	6.87	34.19	50.23	2.14
9	85.04	0.74	0.78	5.16	8.06	0.22	4.95	5.19	34.45	53.95	1.46
	86.86	1.16	1.13	4.13	6 53	.19	8.83	8.60	31.43	49.69	1.45
	92.91	2.33	1.54	5.94	9.21	.28					
	80.74	0.74	.78	1.90	3.20	.14					
1	36.490	2.874	4.623	19.077	35.781	1.155	4.52	7.28	30.04	56.36	1.80
2	27.590	4.760	4.97	24.76	36.87	1.55	6.57	6.86	34.19	50.24	2.14
3	26.920	3.62	3.79	25.18	39.42	1.07	4.95	5.17	34.46	53.96	1.46
4							5.13	7.57	33.06	52.49	1.75
	30.23	3.75	4.46	23.02	37.19	1.25	5.38	6.40	33.06	53.27	1.79
	36.49	4.76	4.97	25.18	39.42	1.55					
	26.92	2.87	3.79	19.08	35.78	1.07					

* Reckoned to this per cent. by the analyst for comparison.

VII. Fruits and Vegetables.

No.	Variety.	Reference.	Analyst.
1	Ruta Bagas. Me., ...	Rep. Me. Ag. Coll., '78, p. 31,	A.M. Farrington
2	Yam. Conn., 1877, ...	Rep. Ct. Ag. Ex. St., '78, p. 16,	S. W. Johnson,
3	Sweet Potato. (Convolvulus batatas) Nansemond Improved, Va., 1876, ...	Am.Jour.Sci.& Arts,'77,p.197,	"
4	Sweet Potato, ...	Rep. U. S. Dept. Ag., '69, p. 76,	T. Antisell,
5	Squash, (Flesh) Marrow Squash. Mass.,	Bull. Bussey Inst., '77, p. 88,	F. H. Storer,
6	" " Hubbard " "	" " " "	"
7	" " Crooked necked Squash. Mass..	" " " "	"
8	Squash, (Rind) Marrow Squash. Mass.,	" " " "	"
9	" " Hubbard " "	" " " 89,	"
10	" " Crooked necked Squash. Mass., ...	" " " 90,	"
11	Squash, (Seeds and stringy matters,) Marrow Squash. Mass., ...	" " " 88,	"
12	Squash, (Seeds and stringy matters,) Hubbard Squash. Mass., ...	" " " 89,	"
13	Squash, (Seeds and stringy matters,) Crooked necked Squash. Mass , ...	" " " 90,	"
14	Pumpkin, (Flesh) common round Yellow. Mass., ...	" " " 83,	"
15	Pumpkin, (Flesh), smaller round Yellow. Mass., ...	" " " 83,	"
16	Pumpkin, (Rind), common round Yellow. Mass..	" " " 84,	"
17	Pumpkin, (Rind), smaller round Yellow. Mass., ...	" " " 84,	"
18	Pumpkin, (Seeds and stringy parts), common round Yellow. Mass., ...	" " " 84,	"
19	Pumpkin, (Seeds and stringy parts,) smaller round Yellow. Mass., ...	" " " 84,	"
20	Apples, (Stem and seeds not included,) R. I. Greening. Conn., ...	Rep.Mid.Ag.Ex.St.,'77–8,p.39,	W. O. Atwater,
21	Apples, (Flesh), Baldwin, '74. Mass., ..	Bull. Bussey Inst., '75, p. 365,	F. H. Storer,
22	" " Roxbury Russet, '74. Mass.,	" " " "	"
23	Apples, (Skin). Baldwin, '74. Mass.,	" " " "	"
24	" " Roxbury Russett, '74. Mass.,	" " " "	"
25	Apple Pomace, from Baldwins chiefly,	" " " "	"

VII. Miscellaneous.

1	Broom Corn Seeds. 1875–6. Boston Seed Store. More plump than 19, ...	Bull. Bussey Inst., '77, p. 99,	F. H. Storer,
2	Broom Corn Seeds. 1876. Hartford, Ct.,	" " " "	"
3	" " " 1876. Youngest anthers not yet fallen.	" " " 100,	"
4	Broom Corn Seeds. 1876 Plants out of flower. Youngest anthers all fallen,	" " " "	"
5	Broom Corn Seeds.'76, Sept. 21. Much more mature than 21. Still soft and unripe,	" " " "	"
6	Sorghum cane (free from leaves, roots and tops,)	Trans. N. Y. Ag. Soc., '61,	C.A. Goessmann,
7	Seeds of Juncus bulbosus, var. Gerardi or Bothnicus, ...	Bull. Bussey Inst., '75, p. 348,	F. H. Storer,
8	Pachyma Cocos. —" tuckahoe "— edible fungus, ...	" " " 370,	"
9	Sapindus marginatus. Soap berry, ...	Rep. Dept. Ag., '70, p. 107,	T. Antisell,
10	Juniperus communius. Juniper berry, ..	" " " "	"

VI. FRUIT AND VEGETABLES.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water Free. Ash.	Water Free. Albuminoids.	Water Free. Fiber.	Water Free. N. fr. Extract.	Water Free. Fat.
1	87.08	1.41	1.15	1.16	9.11	.09	10.91	8.90	8.98	70.51	.07
2	71.23	.67	2.06	.75	25.24	.25	2.31	7.11	2.59	87.13	.86
3	73.39	1.07	1.28	0.98	23 00	.28	4 02	4.81	3.68	86.44	1.05
4	65.96	1.07	.45	2.50	29.72	.30	3.14	1.32	7.35	87.31	.88
5	89.65	0.73	0.96	1.19	7.13	0.34	7.07	9.82	11.52	68.80	3.29
6	85.28	0.91	0.69	0.99	11 98	0.15	6.17	4.52	6.75	81.57	0.99
7	89.33	0.53	1.11	0.95	8.04	0.04	4.94	10.37	8 87	75.44	0.38
8	85.65	1.49	2.81	2.86	6.43	0.76	10.35	19.61	19.93	14.60	5.33
9	79.01	1.13	2.75	3.89	12.42	0.80	5.36	13.11	18.53	14.70	3.83
10	81.85	1.02	2.94	2.82	11.28	0.59	5.49	15.74	15.14	11.99	3.15
11	72.85	1.70	5.75	4.48	7.97	7.75	6.14	20.79	16.22	28.81	28.04
12	66.72	1.64	6.07	6.24	11.77	7.56	4.92	18.22	18.74	35.40	22.72
13	83.82	0.83	3.99	2.05	6.20	3.61	4.93	23.89	12.20	37.44	21.54
14	92.41	0.71	0.87	1.11	4.80	0.10	9.31	11.50	14.64	63.21	1.34
15	94.57	0.63	0.95	0.86	3.05	0.14	11.61	13.75	15.88	56.24	2.52
16	84.44	1.50	2.90	3.92	6.75	0.49	9.64	18.65	25.18	43.41	3.12
17	88.01	1.23	2.68	2.97	4.67	0.49	10.25	21.94	24.75	38.95	4.11
18	75.94	1.66	6.82	3.74	5.21	7.13	6.88	26.26	15.54	21.69	29.63
19	77.79	1.36	5.68	4.12	4.34	6.71	6.14	25.56	18.53	19.56	30.21
20	85.96	0.28	0.27	....	....	....	2.00	1.92	....	....	....
21	84.11	0 23	0.21	0.91	14.26	.28 ?	1.45	1.32	5.73	89.74	1.76
22	82.22	0.26	0.27	0.95	15.77	.53	1.46	1 52	5.34	88.70	2.98
23	71.60	0.45	1.00	5.37	19 31	2.27	1.58	3.52	18.91	68.00	7.99
24	69.93	0.53	1.08	5.02	21.73	1.71	1.76	3.59	16.70	72.26	5.69
25	77.21	0.50	0.98	3.90	15.71	1.70	2.19	4.30	17.11	68.94	7.46

VII. MISCELLANEOUS.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water Free. Ash.	Water Free. Albuminoids.	Water Free. Fiber.	Water Free. N. fr. Extract.	Water Free. Fat.
1	11.20	2.02	6.97	6.67	69.82	3.32	2.27	7.85	7.51	78.63	3.74
2	11.93	2.55	7.56	6.57	68.14	3.25	2.89	8.58	7.46	77.39	3.68
3	5.67	4.18	6.96	26.66	55.45	1.08	4.43	7.38	28.26	58.78	1.15
4	5.97	6.14	9.07	23.90	53.61	1.31	6.53	9.65	25.42	57.01	1.39
5	7.19	4.44	9.02	15.15	62.15	2.05	4.78	9.72	16.32	66.97	2.21
6	78.94	1.24	1.40	8.20	10.22		5.89	6.65	38.94	48.53	
7	7.98	2.65	15.89	22.92	47.23	3.33	2.88	17.39	24.91	51.20	3.62
8	14.51	0.24	1.38	9.80	73.73	0.34	.28	1.61	11.45	86.25	.40
9	18.16	3.61	14.44		63.79		4.41	17.64		77.95	
10	14.34	3.86	5.87		75.93		4.50	6.85		88.65	